FARLOWIA

A JOURNAL OF CRYPTOGAMIC BOTANY

VOL. 2 JULY, 1945 No. 2

A TAXONOMIC AND ECOLOGICAL STUDY OF SOME DIATOMS FROM THE POCONO PLATEAU AND ADJACENT REGIONS

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The Pocono plateau, which is located in the northeastern section of Pennsylvania, is part of the general Appalachian system. Geologically it is mostly sandstone of the Pocono and Catskill formation which was laid down in the late Devonian and early Carboniferous times. Here and there are present local limestone outcrops.

In this study the diatoms were obtained from regions adjacent to as well as in the Pocono plateau. Various types of bodies of water in Carbon, Lackawanna, Luzerne, Monroe, Northampton, Pike, and Wayne County were included. Thus localities on the Martensburg shale, Helderberg, and Chemung formations were also studied.

In this region there are many so-called lakes. From the limnological standpoint these are not lakes but ponds, for they have no thermocline. They are formed in one of two ways; either they are of glacial origin or are dammed up streams. Immediately after the Civil War there was much lumbering in this region. The dams were constructed in the streams to form storage basins for the logs until the spring thaws. At that time they would be floated down stream. After these lumbering operations had ceased these ponds were used as a source of ice. During the winter, ice would be cut and stored in ice houses which were built on the shores of the ponds. With the advent of artificial ice, this business ceased and summer resorts were built about the ponds.

A description of the various localities from which the diatoms were collected is given below. The ecological information concerning these habitats is to be found in the ecological discussion.

LACKAWANNA COUNTY

2044 Indian Lake, from squeezings of surface vegetation, *Hodge*, 7 July 1941

LUZERNE COUNTY

2042 Harvey Lake, from squeezings of the bottom vegetation, in quiet shallow water, *Hodge*, 7 July 1941

2043 Harvey Lake, from squeezings of vegetation in running water at the outlet, *Hodge*, 7 July 1941

MONROE COUNTY

Pocono Lake, a composite collection made by *Mr. F. J. Myers* during the summer of 1940.

262 Jaggie's Bog, *Shulze*

263 Jaggie's Bog, *Shulze*

2010 South Pocono Lake, in a small bay one foot deep, on rocks and on moss and weeds growing on bottom, *Patrick*, 8 July 1941

2011 South Pocono Lake, squeezings from *Sphagnum* in 18 inches of water, *Patrick*, 8 July 1941

2012 A small stream from springs, running under road to Davy's Run, shallow, filled with *Sphagnum*, *Patrick*, 8 July 1941

2013 Shallow ditch along road to Davy's Run, very cold, in shade, *Patrick*, 9 July 1941

2014 Davy's Run, beaver dam, surface mud and scum around weeds, growing in 3–4 inches of water, *Patrick*, 9 July 1941

2015 Davy's Run, in running water below beaver dam, attached or enmeshed in *Fontinalis antipyretica*, *Patrick*, 9 July 1941

2016 Davy's Run, surface ooze in 3–4 inches of water, about 50 feet above beaver dam in shade, *Patrick*, 9 July 1941

2017 Davy's Run, open sun, running water, on or enmeshed in weeds, *Patrick*, 9 July 1941

2018 Davy's Run, deep shade, surface of mud, still, shallow water, *Patrick*, 9 July 1941

2019 Davy's Run, deep shade, rapid water, squeezings from *Hypnum* and *Fontinalis*, *Patrick*, 9 July 1941

2020 Lost Lake, squeezings from *Sphagnum*, *A. Turner*, 5 July 1941

2025 Raymondskill Falls, surface scum on rocks in pool in falls, *Patrick*, 2 July 1941

2031 Mud Run, squeezings from moss in spillway, *Hodge*, July 1941

2032 Tobyhanna Creek, shallow water near flat rocks on side of creek known as "Lover's Leap", *Patrick*, 8 July 1941

2033 Tobyhanna Creek, near bank of creek, *Patrick*, 8 July 1941

2034 Pocono Lake, on stones in 1 foot of water at Emlen dock, *Patrick*, 30 June 1941

2035 Pocono Lake, from squeezings of *Elodea*, *Dicranium*, and *Hypnum* growing in 1 foot of water at Emlen dock, *Patrick*, 30 June 1941

2036 Pocono Lake, from squeezings of *Myriophyllum* in 2 feet of water at Emlen dock, *Patrick*, 30 June 1941

2037 Spring run near Emlen cottage, squeezings from weeds, *C. Myers*, 6 July 1941

2038 Pocono Lake, plankton taken by tow net, *Patrick and Hodge*, 7 July 1941

2039 Lake Tamaque, surface scum, *Hodge*, 7 July 1941

2040 Lake Tamaque, scrapings from log, *Hodge*, 7 July 1941

2045 Popomoning Lake, from squeezings of *Elodea*, *Hodge*, July 1941

2046 Wier Lake, squeezings from surface vegetation, *Hodge*, July 1941

2047 Wier Lake, squeezings from bottom vegetation, *Hodge*, July 1941

2049 Trout Lake, squeezings from *Spirogyra*, *Hodge*, July 1941

2051 Mountain Lake, from squeezings of surface vegetation, *Hodge*, July 1941

2056 Davy's Run, full sun, in running water, enmeshed in *Fontinalis antipyretica*, *Patrick*, 8 July 1941

2065 Pocono Lake, scrapings from logs supporting Emlen's dock, *Patrick*, 10 July 1941

NORTHAMPTON COUNTY

2050 Green Pond, from squeezings of vegetation, *Hodge*, July 1941

PIKE COUNTY

1 Greeley, squeezings from *Fontinalis* in brook running through swamp, *J. Burke*, 4 July 1941

2 Greeley, squeezings from *Sphagnum* in swamp, *J. Burke*, 4 July 1941

3 Shohola Falls, from algae at top of falls, *J. Burke*, 4 July 1941

4 Shohola Falls, from moss at top of falls, in swift water, *J. Burke*, 6 July 1941
5 Lake Wallenpaupek tributary passing under Route 507, *J. Burke*, 5 July 1941
7–9 Shohola Falls, scrapings from dripping rock face, side wall of gorge, above concrete bridge crossing road below falls, *J. Burke*, 5 July 1941
10 Shohola Falls, from algae in brook at head of falls near pond, *J. Burke*, 6 July 1941
11 Shohola Falls, from moss in brook above falls, near pond, *J. Burke*, 6 July 1941
12 Shohola Falls, edge of pond above falls, *J. Burke*, 6 July 1941
13 Shohola Falls, scrapings from dripping wall in small glen at head of falls, *J. Burke*, 6 July 1941
14 Shohola Falls, scrapings from face of rock at side of falls, *J. Burke*, July 1941
15 Shohola Falls, gelatinous algae on rock wall facing falls, *J. Burke*, 6 July 1941
127–130 *J. Shulze* (no other information except Pike County given)
1621–1623 Bushkill Creek, in spring opposite head of island, *J. Shulze*. (I cannot be sure whether this locality is in Pike or Monroe county.)
2188–90 *J. Shulze* (no other information except Pike County given)

WAYNE COUNTY

2021 Angels, Mill Creek, in cool, shallow, swift water on rocks in middle of creek, *J. Burke and R. Patrick*, 5 July 1941
2022 Angels, small tributary of Mill Creek, deep shade, slow running, 2–5 inches deep, *J. Burke and R. Patrick*, 5 July 1941
2023 Angels, Mill Creek tributary, deep shade, from surface of leaves in spring bubbling through sand, *J. Burke and R. Patrick*, 5 July 1941
2024 Angels, scraping from surface of leaves in a very shallow pool or puddle, *J. Burke and R. Patrick*, 5 July 1941
2026 Angels, Mill Creek, full sun, growing on stones in swift, shallow water, *R. Patrick and J. Burke*, 5 July 1941

In this study it was thought wise to consider all obtainable collections that had ever been made in this region. Some of these collections are quite old and no information is available concerning the ecological conditions which existed when the collections were made. Because of this most of the ecological studies are based on a few of the most diversified ponds which were selected for this purpose. Much of the ecological data was obtained by Mr. Frank J. Myers who studied the rotifers present in these bodies of water (Proc. Acad. Nat. Sci. Phila. **94:** 251–286. 1942). The information concerning the calcium, bicarbonates, and color of the water was furnished by Dr. Thomas Edmondson, Woods Hole Oceanographic Laboratories.

In the study of all collections, hyrax mounts were made and the species identified were ringed by means of a diamond marker. In the taxonomic discussion under each species the localities are given in which the species were found and the number in parenthesis indicates the slide in the herbarium of the Academy of Natural Sciences of Philadelphia on which the identification was made.

The materials prepared for the ecological studies were made from a quantitative standpoint. The original amount of material collected in each case was as nearly as possible the same. If collections were made for epiphytic diatoms, one-half pint (236 c.c.) of weeds or debris was collected and squeezed. The drippings were retained and concentrated, and one half of this concentrate was cleaned. The cleaned material in each case was diluted

to a common dilution factor. This solution was then well shaken and immediately one tenth of a cubic centimeter was withdrawn and deposited on a cover glass. Methods comparable to these were also used for the planktonic and encrusted forms.

In this study five terms have been used to denote the relative abundance of the species found. The slides, with the aid of a mechanical stage, were methodically studied. In most cases a 3 mm. objective was used in making these counts. However, when large forms were being studied a 16 mm. objective was used. "Rare" indicates that only a very few specimens were found on the slides studied. "Frequent" indicates that one or two specimens were present in about fifty per cent of the fields of the microscope. "Very frequent" indicates that an average of two or three specimens were found in each field. "Common or abundant" indicates that several specimens were found in each field.

The author is particularly indebted to Mr. Frank J. Myers who furnished much valuable information which he had obtained concerning these bodies of water, and who also made available the equipment of his summer laboratory at Pocono Lake Preserve. The author also wishes to express her appreciation to Dr. Thomas S. Stewart who made the photographs included in the plates; to Dr. Thomas Edmondson who made the chemical analysis of the water; to Miss Jane Stenz who made the slides for this study; to Mr. Joseph Burke who made available his collections from Pike County; to Dr. Francis W. Pennell for his help with Latin descriptions; and to Miss Hilda F. Harris of the Farlow Herbarium, to Mrs. Gertrude Hess of the library of the American Philosophical Society, and to Mr. Frank Patrick who made available additional literature necessary for this study.

MELOSIRA AGARDH

A. Sulcus absent, in girdle view frustule very finely striated ... **M. varians**
A. Sulcus present
  B. Sulcus a distinct concave throat or channel
    C. Lives in running water on rocks or in moss; in valve view, puncta arranged in definitely radiating rows ..... **M. roeseana** and var.
    C. Typically a pelagic form ..... **M. ambigua**
  B. Sulcus a narrow groove ..... **M. italica**

Melosira ambigua Müller, 1905, Bot. Jahrb. Syst. Pflanzengesch. u. Pflanzengeog. **34:** 283. *pl. 4, figs. 9, 10.*

For a discussion of this species see my paper in Proceedings of the Academy of Natural Sciences of Philadelphia **92:** 195. 1941.

This species was very frequent in a gathering made by Shulze in Pike County. Unfortunately we have no habitat data concerning this collection. Krieger (1929) states it is found in waters with a pH of 5.5–7.8.

Monroe County: Pocono Lake Preserve, Pocono Lake, 2036 *Patrick* (A-2148), 2038 *Patrick* (A-2152); Tobyhanna Creek, 2033 *Patrick* (A-2142); Trout Lake, 2047 *Hodge* (A-2172). Pike County: 127–128 *Shulze* (A-2215–17).

Melosira italica (Ehr.) Kütz., 1844, Bacill., p. 55. *pl. 2, fig. 6.*
Gaillonella italica Ehr., 1836, Ber. K. Akad. Wiss. Berlin **1836:** 53.

This species was common in the pond above Shohola Falls.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131); Jaggie's Bog, 262 *Shulze* (A-2223). Pike County: 130 *Shulze* (A-2221); Shohola Falls, 10–11 *Burke* (A-2201–02), 12 *Burke* (A-2204), 14 *Burke* (A-2209).

Melosira roeseana Rabh., 1852, Algarum Europaea no. 382, 1853, Sussw. Diat., p. 13. *pl. 10, suppl. fig. 5.*

It is hard for me to be sure of the difference between *M. roeseana* and *M. roeseana* v. *epidendron.* I have checked my specimens with those of Rabenhorst's on Rabh. Alg. Sach. Resp. Mitteleurop. no. 383 and with Van Heurck's Type Slide no. 465. I find that *M. roeseana* on these slides has the ridges, perhaps spines, on the margins of the valve arranged at regular intervals, usually between each stria. In *Melosira roeseana* v. *epidendron* according to Van Heurck's figure (Syn. Diat. Belgique, *pl. 89, figs. 17–18*) and in Van Heurck's Type Slide no. 467 the spines are irregularly arranged. Also the structure of variety *epidendron* seems to be somewhat coarser.

This species was present only in the locality given below.

Pike County: Shohola Falls, 15 *Burke* (A-2211).

Melosira roeseana v. **epidendron** (Ehr.) Grun. *apud* Van Heurck, 1882, Syn. Diat. Belgique, *pl. 89, figs. 17, 18.*
Sphenosira epidendron Ehr., 1848, Ber. K. Akad. Wiss. Berlin **1848:** 219.

In collection no. 7 of Burke were found specimens which differ in number of striae in 10 μ from the figure in Van Heurck's Synopsis Diatomées Belgique. In girdle view the striae are 17–18 in 10 μ instead of 14 in 10 μ.

This variety was of frequent occurrence in the collections cited.

Pike County: Shohola Falls, 7–9 *Burke* (A-2196–98).

Melosira varians Ag., 1827, Flora (Bot. Zeit.) **10** (2): 628.

This species though present in two habitats was not of frequent occurrence in either.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: Shohola Falls, 4 *Burke* (A-2192).

CYCLOTELLA KÜTZING

A. Valves circular, center of valve marked by radiating lines producing a star-shaped pattern ..... **C. stelligera**

A. Center of valve otherwise marked or clear

B. Marginal striae interspersed with thickenings, middle field of valve filled with radiating punctae ..... **C. comta v. radiosa**

B. Marginal striae without such thickenings **C. Meneghiniana v. rectangulata**

Cyclotella comta v. **radiosa** Grun. *apud* Van Heurck, 1882, Syn. Diat. Belgique, *pl. 92, fig. 23,* text (1885) p. 214.

Though only found in one habitat it was common there. Hustedt states that it is especially found in sub-alpine lakes. It seems to be found most commonly in this country in habitats north of or above the frost line.

Luzerne County: Harvey Lake, 2042–43 *Hodge* (A-2160–63).

Cyclotella Meneghiniana v. **rectangulata** Grun. *apud* Van Heurck, 1882, Syn. Diat. Belgique, *pl. 94, figs. 17–19.*

Pike County: Shohola Falls, 4 *Burke* (A-2192), 10–11 *Burke* (A-2200–02).

Cyclotella stelligera (Cl. and Grun.) Van Heurck, 1882, Syn. Diat. Belgique, *pl. 94, figs. 22–27.*

Cyclotella Meneghiniana v. ? *stelligera* Cl. and Grun. *apud* Cl., 1881, K. Sv. Vet. Akad. Handl. **18** (5): 22.

This species was found only once and then it was rare.

Monroe County: Trout Lake, 2049 *Hodge* (A-2174).

ODONTIDIUM KÜTZING EMEND. BESSEY

Odontidium anceps Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 127.

This species was rare in several localities. It was common in very shallow water, on the surface of leaves at Angels, Wayne County. The temperature of the water was between 50–60° F.

Pike County: 2188–90 *Shulze* (A-2234–36), 128 *Shulze* (A-2217); Lake Wallenpaupek tributary, 5 *Burke* (A-2195). Wayne County: Angels, 2021 *Burke and Patrick* (A-2123), 2023–24 *Burke and Patrick* (A-2127–29).

Odontidium hiemale v. **mesodon** (Ehr.) Grun., 1862, Verh. Zool. Bot. Ges. Wien **12:** 357.

Fragilaria mesodon Ehr., 1839, Abhandl. K. Akad. Wiss. Berlin **1838:** 57. *pl. 2, fig. 9.*

This variety was very frequent in shallow running water at Angels, and in squeezings from the bottom vegetation of shallow water in Wier Lake.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131); Wier Lake, 2046–47 *Hodge* (A-2169–70). Pike County: 127 *Shulze* (A-2215); Lake Wallenpaupek Tributary, 5 *Burke* (A-2195); Shohola Falls, 15 *Burke* (A-2211). Wayne County: Angels, 2021–24 *Burke and Patrick* (A-2123–29), 2026 *Burke and Patrick* (A-2134).

TABELLARIA EHRENBERG

Tabellaria fenestrata (Lyngb.) Kütz., 1844, Bacill., p. 127. *pl. 17, fig. 22; pl. 18, fig. 2; pl. 30, fig. 73.*

Diatoma fenestratum Lyngbye, 1819, Tent. Hydrophyt. Danicae, p. 180. *pl. 61, fig. 3.*

From this study it would seem that this species preferred shallow water. It is of very frequent or common occurrence in Mud Run, Pocono Lake, Tobyhanna Creek and the pond above Shohola Falls, in scrapings from dripping rocks.

Lackawanna County: Indian Lake, 2044 *Hodge* (A-2164). Luzerne County: Harvey Lake, 2042 *Hodge* (A-2161). Monroe County: Pocono Lake Preserve, Mud Run, 2031 *Hodge* (A-2138); Pocono Lake, 2034–36 *Patrick* (A-2144–48), 2038 *Patrick* (A-2152), 2065 *Patrick* (A-2182), *F. Myers* (A-2213); South Pocono Lake, 2010–11 *Patrick* (A-2101–04); Tobyhanna Creek, 2032–33 *Patrick* (A-2140–42); Lake Tamaque, 2039 *Hodge* (A-2154); Wier Lake, 2046 *Hodge* (A-2168). Pike County: 2188–90 *Shulze* (A-2233–36), 127–30 *Shulze* (A-2215–21); Greeley, 1 *Burke* (A-2184); Shohola Falls, 10–14 *Burke* (A-2201–10).

Tabellaria flocculosa (Roth) Kütz., 1844, Bacill., p. 127. *pl. 17, fig. 21.*

Conferva flocculosa Roth, 1797, Catalecta Botanica Fasc. 1, p. 192. *pl. 4, fig. 4; pl. 5, fig. 6.* (This reference was checked for me by Miss Harris of the Farlow Library.)

This species was very frequent or common in Pocono Lake, Mud Run, Tobyhanna Creek, Davy's Run and Shohola Falls. It seems to prefer somewhat more acid conditions than the preceding species and is often found associated with moss. Krieger (1929) states it prefers pH 3.5–5.5.

Monroe County: Davy's Run, 2014–19 *Patrick* (A-2109–19), 2056 *Patrick* (A-2180); Jaggie's Bog, 262 *Shulze* (A-2223); Pocono Lake Preserve, Mud Run, 2031 *Hodge* (A-2138); Pocono Lake, 2034–36 *Patrick* (A-2144–48), 2038 *Patrick* (A-2152), 2065 *Patrick* (A-2182), *F. Myers* (A-2213); Tobyhanna Creek, 2032–33 *Patrick* (A-2140–42); South Pocono Lake, 2010 *Patrick* (A-2102); Popomoning Lake, 2045 *Hodge* (A-2166); Raymondskill Falls, 2025 *Patrick* (A-2131); Trout Lake, 2049 *Hodge* (A-2174); Wier Lake, 2047 *Hodge* (A-2170). Pike County: 2188–89 *Shulze* (A-2233–35); Bushkill Creek, 1621–23 *Shulze* (A-2227–31); Greeley, 1–2 *Burke* (A-2184–88); Shohola Falls, 3–4 *Burke* (A-2190–92), 10–14 *Burke* (A-2200–10). Wayne County: Angels, 2021 *Burke and Patrick* (A-2124).

MERIDION AGARDH

Meridion circulare (Grev.) Ag., 1831, Consp. Crit. Diat., p. 40.

Echinella circulare Grev., 1822, Mem. Werner. Nat. Hist. Soc. **4** (1): 213–15. *pl. 8, fig. 2.*

The specimens most commonly found in this study differ from the type in having the apex or head end of the valve acute instead of rounded. This species reached its best development in shallow, flowing, somewhat acid waters; — in a tributary of Mill Creek, in a brook running through a swamp at Greeley, at Jaggie's Bog, and at Shohola Falls.

Luzerne County: Harvey Lake, 2042 *Hodge* (A-2161). Monroe County: Davy's Run, 2014–15 *Patrick* (A-2109–11), 2018–19 *Patrick* (A-2117–19); Jaggie's Bog, 262 *Shulze* (A-2223); Pocono Lake Preserve, Mud Run, 2031 *Hodge* (A-2138); Tobyhanna Creek, 2033 *Patrick* (A-2142); Trout Lake, 2049 *Hodge* (A-2174); Wier Lake, 2046–47 *Hodge* (A-2169–70). Pike County: 128 *Shulze* (A-2217), 130 *Shulze* (A-2221); Bushkill Creek, 1621–23 *Shulze* (A-2227–31); Greeley, 1 *Burke* (A-2184); Shohola Falls,

3–4 *Burke* (A-2190–92), 10 *Burke* (A-2200), 14 *Burke* (A-2208). Wayne County: Angels, 2021–22 *Burke and Patrick* (A-2123–25), 2026 *Burke and Patrick* (A-2134).

Meridion circulare v. **constricta** (Ralfs) Van Heurck, 1881, Syn. Diat. Belgique, *pl. 51, figs. 14, 15*, text (1885) p. 161.

Meridion constrictum Ralfs, 1843, Ann. Mag. Nat. Hist. **12:** 458. *pl. 18, fig. 2.*

This variety was found most often in Wayne County. As contrasted with the species the only habitat in which it was very frequent was from scrapings of dead leaves in a small, very shallow puddle at Angels.

Monroe County: Davy's Run, 2016 *Patrick* (A-2113); Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: 127 *Shulze* (A-2215); Greeley, 2 *Burke* (A-2188); Shohola Falls, 11 *Burke* (A-2203), 12 *Burke* (A-2204). Wayne County: Angels, 2021–24 *Burke* (A-2124–29).

FRAGILARIA LYNGBYE

A. Valves united to each other at middle portion of valve, thus having the ends of the valve separate and free ..... **F. crotonensis**

A. Valves forming bands by other methods

B. Axial area linear and narrow, sometimes lacking or indistinct, central area lacking. See B′ and B″

C. Valve constricted at center ..... **F. undata v. lobata**

C. Valve not constricted

D. Valve elliptic or linear with rounded ends, striae about 11 in 10 μ ..... **F. pinnata**

D. Valve linear or lanceolate in shape, striae more numerous

E. Valve capitate

F. Some of the striae not opposite each other on either side of the pseudoraphe thus producing an irregular effect ..... **F. bicapitata**

F. Striae regular, not as above .. **F. virescens** var.

E. Valve not capitate ..... **F. virescens**

B′. Axial area linear and narrow, central area present

G. Central area bilateral, valve constricted in the middle **F. capucina** var.

G. Central area unilateral, valve swollen on one side **F. Vaucheriae**

B″. Axial area more or less lanceolate, wider at center than at ends of valve

H. Striae very coarse, 6–8 in 10 μ ..... **F. leptostauron**

H. Striae much finer, 14–17 in 10 μ

I. Striae marginal

J. Valve elliptical ..... **F. elliptica**

J. Valve lanceolate with rostrate ends .**F. brevistriata**

I. Striae longer, valves linear or lanceolate ...**F. construens**

Fragilaria bicapitata A. Mayer, 1917, Denks. K. Bayer. Bot. Ges. **13:** n.s. **7:** 21. *pl. 1, fig. 26.*

This species was only once of very frequent occurrence and that was in

Wier Lake in association with bottom vegetation in shallow water. The pH was 6.6.

Monroe County: Wier Lake, 2046–47 *Hodge* (A-2169–70).

Fragilaria brevistriata Grun. *apud* Van Heurck, 1881, Syn. Diat. Belgique, *pl. 45, fig. 32*, text (1885) p. 157.

This species was rare in the two localities in which it was found.

Monroe County: Wier Lake, 2046 *Hodge* (A-2169).

Fragilaria capucina v. **mesolepta** Rabh., 1864, Flora Europaea Algarum, p. 118.

This variety was rare in the localities given below.

Monroe County: Popomoning Lake, 2045 *Hodge* (A-2166); Mountain Lake, 2051 *Hodge* (A-2178). Pike County: 2189 *Shulze* (A-2235), 128 *Shulze* (A-2217).

Fragilaria construens (Ehr.) Grun., 1862, Verh. Zool. Bot. Ges. Wien **12:** 371. *pl. 7, fig. 10.*

Staurosira construens Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin, **1841:** 424.

This species was found only in Pocono Lake, and then it was rare.

Monroe County: Pocono Lake Preserve, Pocono Lake, 2034 *Patrick* (A-2144), 2035 *Patrick* (A-2146), *F. Myers* (A-2213).

Fragilaria crotonensis Kitton, 1869, Science Gossip **1869:** 110. *fig. 81.*

This species was very frequent in one locality. It was probably washed into the brook from the lake.

Pike County: Shohola Falls, 10 *Burke* (A-2200).

Fragilaria elliptica Schuman, 1867, Schrift. Phys. Ökon. Ges. Königsburg **8:** 52. *pl. 1, fig. 5.*

This species was common in one collection: squeezings from littoral bottom vegetation in Lake Wier.

Monroe County: Wier Lake, 2047 *Hodge* (A-2170). Pike County: tributary of Lake Wallenpaupek, 5 *Burke* (A-2195).

Fragilaria leptostauron (Ehr.) Hustedt, 1931, in Rabenhorst's Krypt.-Flora, **7**(2): 153. *fig. 668a-f.*

Biblarium leptostauron Ehr., 1854, Mikrogeologie, *pl. 5, fig. II, 24, pl. 12, figs. 35, 36.*

This species was rare in the three habitats.

Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195). Wayne County: Angels, 2021–22 *Burke and Patrick* (A-2124–25).

Fragilaria pinnata Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 415.

This species was rare in occurrence.

Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195).

Fragilaria undata v. **lobata** var. nov.

Valvae constrictae ad medium, longae 20–54 μ, apicibus porrectis, pseudoraphe nulla, striis transversis tenuibus 16–17 in 10 μ.

William Smith (Ann. Mag. Nat. Hist. 2d ser. **15:** 7. *pl. 1, fig. 7*) first refers to this variety as *F. undata* v. γ. What may be this variety, though we cannot be sure as only the outline is shown and Ehrenberg questions it being in the genus *Fragilaria*, is given as *F. constricta* Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 415. *pl. 1, fig. I, 21*; *pl. 3, fig. VI, 10.* Hustedt has placed in synonymy the specimens of W. Smith under Ehrenberg's name, *Fragilaria constricta*, and has clearly stated in his description that there are horns or spines on the margins of the valve. He has cited as reference Tempère and Peragallo, 2d Ed. Diatomées du Monde Entier nos. 831, 868, 907, 939. I have checked these slides and also one from Christiana (Febiger 3437) which may be one of W. Smith's collections. In none of these specimens do I find any evidence of spines. It is true that on two specimens from Pocono Lake I saw evidence of spines, but this condition seems to be the exception rather than the rule.

Since Ehrenberg clearly indicates that he is doubtful about placing his species in the genus *Fragilaria* and also since one cannot be sure from his short description just what he had, I believe it best to make this form a variety of W. Smith's *F. undata.* The specimens of W. Smith which he considered typical for *F. undata* are very different from the figures of Ehrenberg for *F. constricta.*

Monroe County: Pocono Lake Preserve, Pocono Lake, *F. Myers* (A-2213). Pike County: Shohola Falls, 13–14 *Burke* (A-2206–09).

Fragilaria Vaucheriae (Kütz.) Boye, 1938, Bot. Not. **1938**(1–3): 164–71.
Exilaria Vaucheriae Kütz., 1833, Linnaea **8:** 560. *pl. 15, fig. 38*; Kütz. Dec. no. 24.

Though found in several habitats this species was frequent in none.

Luzerne County: Harvey Lake, 2042 *Hodge* (A-2160). Monroe County: Davy's Run, 2018 *Patrick* (A-2118); Trout Lake, 2049 *Hodge* (A-2174); Wier Lake, 2047 *Hodge* (A-2170). Pike County: Shohola Falls, 3 *Burke* (A-2190), 11 *Burke* (A-2202). Wayne County: Angels, 2026 *Burke and Patrick* (A-2134).

Fragilaria virescens Ralfs, 1843, Ann. Mag. Nat. Hist. **12:** 110. *pl. 2, fig. 6.*

This species was very frequent in squeezings from *Hypnum* and *Fontinalis* in Davy's Run, from the swamp at Greeley, from surface of dead leaves in shallow water at Angels, and from a locality of Shulze which was merely designated as Pike County.

Monroe County: Davy's Run, 2014 *Patrick* (A-2110), 2016–19 *Patrick* (A-2113–19), 2056 *Patrick* (A-2180); Pocono Lake Preserve, Mud Run, 2031 *Hodge* (A-2138); Pocono Lake, 2037 *Patrick* (A-2150), *F. Myers* (A-2213); Tobyhanna Creek, 2032–33 *Patrick* (A-2140–42). Pike County: 2188–90 *Shulze* (A-2233–36); 127–130 *Shulze* (A-2215–21); Bushkill Creek, 1621 *Shulze* (A-2227); Greeley, 1 *Burke* (A-2184); Shohola Falls, 14 *Burke* (A-2208–10). Wayne County: Angels, 2024 *Burke and Patrick* (A-2129), 2026 *Burke and Patrick* (A-2134).

Fragilaria virescens v. **capitata** Oestrup, 1910, Danske Diat., p. 193. *pl. 5, fig. 125.*

In Jaggie's Bog this variety was very frequent.

Monroe County: Jaggie's Bog, 262 *Shulze* (A-2223); Pocono Lake Preserve, Pocono Lake, *F. Myers* (A-2213). Pike County: 128 *Shulze* (A-2217). Wayne County: Angels, 2024 *Burke and Patrick* (A-2129).

ASTERIONELLA HASSALL

Asterionella formosa Hassall, 1855, Microscopical Examination of Water, p. 10. (As stated in previous papers I have been unable to verify this reference.)

This species reaches its best development in eutrophic water, though, as seen from this study, it can grow in slightly distrophic water but does not flourish so abundantly.

Luzerne County: Harvey Lake, 2042–43 *Hodge* (A-2161–62). Monroe County: South Pocono Lake, 2010 *Patrick* (A-2102); Tobyhanna Creek, 2033 *Patrick* (A-2142); Pocono Lake, 2034–36 *Patrick* (A-2144–49), 2038 *Patrick* (A-2152); Trout Lake, 2049 *Hodge* (A-2175).

Asterionella Ralfsii W. Sm., 1856, Brit. Diat., **2:** 81.

This species, unlike the one above, seems from this study to have its best development in strongly distrophic, acid water. It reaches its best development in Lake Tamaque with a pH of 3.8, and is frequent in Lost Lake.

Monroe County: Lost Lake, 2020 *Turner* (A-2121); Lake Tamaque, 2039 *Hodge* (A-2154). Pike County: Shohola Falls, 14 *Burke* (A-2210).

SYNEDRA EHRENBERG

A. Striae typically 15 or more in 10 μ, often small diatoms with rather delicate structure
  B. Ratio of breadth to length 1:11 or greater ..... **S. minuscula**
  B. Ratio of breadth to length less than above, central area distinct, often the valve slightly swollen at the central area ..... **S. rumpens** and vars.

A. Striae less than 15 in 10 μ
  C. Central area usually broader than long, striae 12 or less in 10 μ **S. ulna** and vars.
  C. Central area longer than broad, striae 12–14 in 10 μ, sometimes appearing very delicate ..... **S. acus** and vars.

Synedra acus Kütz., 1844, Bacill., p. 68. *pl. 15, fig. 7.*

This species was frequent among the moss growing at the top of Shohola Falls in swift water. This is evidently not the most desirable habitat for this species.

Pike County: Shohola Falls, 4 *Burke* (A-2192), 10 *Burke* (A-2201).

Synedra acus v. **delicatissima** (W. Sm.) Grun. *apud* Van Heurck, 1885, Syn. Diat. Belgique, p. 151.

Synedra delicatissima W. Sm., 1853, Brit. Diat., **1:** 72.

In W. Smith's original description he states that this diatom may vary from 130 to 220 μ (he gives it in terms of inches).

This variety was frequent in the surface water of Mountain Lake, pH 7.3.

Monroe County: Popomoning Lake, 2045 *Hodge* (A-2166); Mountain Lake, 2051 *Hodge* (A-2178).

Synedra minuscula Grun. *apud* Van Heurck, 1881, Syn. Diat. Belgique, *pl. 39, fig. 13.*

Though found in several habitats this species was of frequent occurrence in none.

Monroe County: Davy's Run, 2014 *Patrick* (A-2110), 2017 *Patrick* (A-2115), 2019 *Patrick* (A-2119), 2056 *Patrick* (A-2180); Pocono Lake Preserve, Tobyhanna Creek, 2032 *Patrick* (A-2140); Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195); Shohola Falls, 4 *Burke* (A-2192), 10–11 *Burke* (A-2200–02), 13–14 *Burke* (A-2206–08). Wayne County: Angels, 2022 *Burke and Patrick* (A-2125), 2026 *Burke and Patrick* (A-2134).

Synedra rumpens Kütz., 1844, Bacill., p. 69. *pl. 16, fig. VI, 4, 5.*

Though found in several habitats this species was always rare.

Monroe County: Davy's Run, 2019 *Patrick* (A-2119); Mountain Lake, 2051 *Hodge* (A-2178); Raymondskill Falls, 2025 *Patrick* (A-2131); Trout Lake, 2049 *Hodge* (A-2175). Pike County: Shohola Falls, 3–4 *Burke* (A-2190–92), 10 *Burke* (A-2200). Wayne County: Angels, 2021 *Burke and Patrick* (A-2124).

Synedra rumpens v. **familiaris** (Kütz.) Grun. *apud* Van Heurck, 1881, Syn. Diat. Belgique, *pl. 40, figs. 15, 16.* (Grunow questions whether this should be a variety.)
Synedra familiaris Kütz., 1844, Bacill., p. 68, *pl. 15, fig. 12.*

Monroe County: Wier Lake, 2046–47 *Hodge* (A-2169–70). Wayne County: Angels, 2026 *Burke and Patrick* (A-2134).

Synedra rumpens v. **scotica** Grun. *apud* Van Heurck, 1881, Syn. Diat. Belgique, *pl. 40, fig. 11.*

Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195). Wayne County: Angels, 2021 *Burke and Patrick* (A-2123).

Synedra ulna (Nitzsch) Ehr., 1832, Abhandl. K. Akad. Wiss. Berlin **1831:** 87.
Bacillaria ulna Nitzsch, 1817, N. Schrift. Naturf. Ges. Halle **3**(1): 99.

In these collections were found specimens which agree with *S. ulna* in regard to number of striae and the ratio between length and breadth but which had a central area which was longer than broad, as found in *S. acus.*

This species was common in the squeezings from surface vegetation of Wier Lake.

Monroe County: Mountain Lake, 2051 *Hodge* (A-2178); Raymondskill Falls, 2025 *Patrick* (A-2131); Wier Lake, 2046 *Hodge* (A-2169). Pike County: 127 *Shulze* (A-2215); Bushkill Creek, 1623 *Shulze* (A-2231); Lake Wallenpaupek tributary, 5 *Burke* (A-2195). Wayne County: Angels, 2022 *Burke and Patrick* (A-2125), 2026 *Burke and Patrick* (A-2134).

Synedra ulna v. **danica** (Kütz.) Van Heurck, 1881, Syn. Diat. Belgique, *pl. 38, fig. 14a*, text (1885) p. 151.

Synedra danica Kütz., 1844, Bacill., p. 66. *pl. 14, fig. 13.*

This variety was very frequent in Mountain Lake, a shallow tributary of Mill Creek, and at Shohola Falls. It is often a plankton form and it is unusual to find it so well developed in running water.

Monroe County: Mountain Lake, 2051 *Hodge* (A-2178); Popomoning Lake, 2045 *Hodge* (A-2166). Pike County: 2188–89 *Shulze* (A-2233–35); Bushkill Creek, 1621–23 *Shulze* (A-2227–31); Shohola Falls, 3–4 *Burke* (A-2190–92), 10–14 *Burke* (A-2200–10). Wayne County: Angels, 2022 *Burke and Patrick* (A-2125).

Synedra ulna v. **oxyrhynchus** (Kütz.) Van Heurck, 1885, Syn. Diat. Belgique, p. 151.

Synedra oxyrhynchus Kütz., 1844, Bacill., p. 66. *pl. 14, fig. 8, 2, IX–XI.*

This species was found only twice and then it was rare.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131). Wayne County: Angels, 2026 *Burke and Patrick* (A-2134).

Synedra ulna v. **Ramesii** (Herib. and Perag.) Hustedt *apud* Pascher, 1930, Süssw. Flora Mitteleurop. **10:** 152. *fig. 163.*

Synedra Ramesii Herib. and Perag., 1903, Diat. Foss. d'Auvergne, p. 80. *pl. 11, fig. 28.* (This reference was checked through the kindness of Miss Harris of the Farlow Library.)

This variety was only found once and then it was rare.

Wayne County: Angels, 2021 *Burke and Patrick* (A-2124).

EUNOTIA EHRENBERG

A. Dorsal and ventral margins of valve parallel or nearly so

B. Valve with raphe extending backward from terminal nodules, a jelly pore present at one end of valve ..... **E. flexuosa**

B. Valve not as above

C. Valve strongly arcuate, spanning about 120° .. **E. elegans**

C. Valves not so strongly arcuate

D. Relatively large forms

E. Ends of valve distinctly wider than rest of valve, somewhat wedge-shaped

F. Valves slightly swollen in middle **E. formica**

F. Valves not swollen in the middle **E. tautonensis**

E. Ends of valve not distinctly wider than rest of valve, but capitate, striae coarse, 8–10 in 10 μ **E. monodon v. major**

D. Relatively narrow forms

G. Ends of valve distinctly capitate on dorsal margin, ventral margin flat. See G′ and G″.

H. Valve arcuate

I. Striae 14–17 in 10 μ, terminal nodules small **E. lunaris v. capitata**

I. Striae 10–13 in 10 μ, terminal nodules large **E. gracilis**

I. Striae 12–14 in 10 μ, terminal nodules distinct but not large **E. arcus v. curta**

H. Valve not arcuate, sometimes slightly curved, striae 12–15 in 10 μ ..... **E. fallax**

G'. Ends of valve not capitate

J. Ends rounded, valve lunate in shape **E. lunaris**

J. Ends rounded, cell wall thick, valve only slightly arched ..... **E. valida**

G''. Ends of valve narrowed and attenuate

K. Valve very narrow, striae 15–20 in 10 μ **E. Naegelii**

K. Breadth and length of valve variable, sometimes swollen at ends of valve, valves frequently occurring in long chains ..... **E. pectinalis** and vars.

A. Dorsal margin smooth, convex, ventral margin straight or somewhat concave

L. Ends of valve distinctly set off from rest of valve

M. Typically large forms with coarse striae, not more than 12 in 10 μ

N. Valves with ventral margin straight or only slightly concave, ends of valve formed by a distinct narrowing of the valve, ends truncate ..... **E. praerupta** and vars.

N. Ends of valve somewhat arcuate

O. Ends slightly swollen to form rounded apices **E. monodon**

O. Ends distinctly capitate ..... **E. indica**

M. Typically small forms, striae more than 15 in 10 μ

P. Dorsal margin only slightly convex, ends strongly capitate, usually as wide if not wider than main part of valve **E. exigua**

P. Dorsal margin strongly convex

Q. Ends of valve more or less capitate

R. Striae about 21 in 10 μ ... **E. Meisteri**

R. Striae 15–19 in 10 μ ..... **E. septentrionalis**

Q. Ends of valve not capitate ..... **E. rostellata**

L. Ends of valve not distinctly set off from rest of valve

S. Striae 16 or more in 10 μ

T. Dorsal margin of valve somewhat pointed in the middle, thus giving the margin a slightly wedged appearance **E. trinacria**

T. Dorsal margin of the valve smoothly convex, not as above **E. tenella**

S. Striae usually 15 or less in 10 μ

U. Ends of valve distinct from rest of valve, ends attenuate, rounded ..... **E. sudetica**

U. Ends of valve not distinct from rest of valve

V. Ends of valve acute, giving a sharp pointed appearance to the ends of the valves, sometimes slightly rounded **E. veneris**

V. Ends of valve broadly rounded. . **E. faba**

A. Valve with dorsal margin with definite undulations

W. Valves small, two to five undulation on dorsal margin, striae about 18 in 10 μ ..... **E. microcephala**

W. Valves more robust, striae 15 or less in 10 μ

X. Ends of valve distinctly attenuate, undulations serrate, breadth of valve 7–11 μ. See X′ and X″. ..... **E. septena**

X′. Ventral margin almost straight, undulations on dorsal margin crenate, two in number

Y. Ends of valve distinctly truncate

Z. Undulations well developed .... **E. suecica**

Z. Undulations formed by a slight constriction in the dorsal margin ..... **E. praerupta v. bidens**

Y. Ends of valve not truncate, but rounded **E. diodon**

X″. Ventral margin more or less concave, undulations crenate, four or more ..... **E. robusta**

Eunotia arcus v. **curta** (Grun.) Schönf., 1906, p. 116.

Himantidium arcus v. *curtum* Grun., 1862, Verh. Zool. Bot. Ges. Wien **12:** 339. *pl. 6, fig. 16.*

The identity of these specimens has been checked with Van Heurck's Type Slide No. 268. My specimens vary in length, some of them being 30 μ long. The striae are 12 in 10 μ.

Monroe County: Jaggie's Bog, 262 *Shulze* (A-2223). Pike County: 127 *Shulze* (A-2215).

Eunotia diodon Ehr., 1837, Ber. K. Akad. Wiss. Berlin **1837:** 45.

This species, though found in several localities, was never represented by more than a few specimens. Hustedt states that it is typically found on bare rocks in Northern Europe, and also in damp moss. This corresponds to the type of habitat where it was found in this study.

Monroe County: Davy's Run, 2015 *Patrick* (A-2111), 2019 *Patrick* (A-2119). Pike County: 127–128 *Shulze* (A-2215–17); Bushkill Creek, 1621 *Shulze* (A-2227); Shohola Falls, 14 *Burke* (A-2208).

Eunotia elegans Oestrup, 1910, Danske Diat. p. 172. *pl. 5, fig. 105.*

I believe this is the first time this species has been recorded from North America. The length of the valve measuring along its curvature was 48.7 μ, the breadth was two μ. The striae were 24–25 in 10 μ. This species was found in one collection.

Pike County: Greeley, 2 *Burke* (A-2188).

Eunotia exigua (Breb.) Rabh., 1864, Flora Eur. Algarum, p. 73.

Himantidium exiguum Breb. *ex* Kütz., 1849, Spec. Algarum, p. 8.

This species was rare in all habitats. Krieger (1929) says it is found in pH 3.5–5.5, especially with *Sphagnum*.

Monroe County: Davy's Run, 2019 *Patrick* (A-2119). Pike County: 2188 *Shulze* (A-2234); Bushkill Creek, 1623 *Shulze* (A-2231).

Eunotia faba Ehr. *emend.* Van Heurck, 1881, Syn. Diat. Belgique, p. 143. *pl. 34, fig. 34.*
Eunotia faba Ehr., 1837, Ber. K. Akad. Wiss. Berlin, **1837:** 45.

In all three habitats, this species occurred in running water associated with *Fontinalis* or other plants living in water. It was rare in all habitats.

Monroe County: Davy's Run, 2017 *Patrick* (A-2115); Pocono Lake Preserve, Spring Run, 2037 *C. Myers* (A-2150). Pike County: Greeley, 1 *Burke* (A-2184).

Eunotia fallax A. Cl., 1895, Bihang K. Sv. Vet. Akad. Handl. **21** (3) no. 2: 33. *pl. 1, fig. 35.*

Monroe County: Tobyhanna Creek, 2032 *Patrick* (A-2140).

Eunotia flexuosa Breb. *ex* Kütz., 1849, Spec. Algarum, p. 6.

The forms of this species found during this study were shorter and narrower than in typical specimens of the species. The ends were not inflated. I have carefully studied these forms and checked them with the isotype specimens in H. L. Smith, Spec. Typicae No. 555. These specimens differ a great deal from those which I found in my study of Brazilian diatoms, which have distinctly capitate ends.

The specimens were found in distinctly acid water. This species was of common occurrence in Bushkill Creek and at the edge of the pond at Shohola Falls.

Monroe County: Mountain Lake, 2051 *Hodge* (A-2178); Pocono Lake Preserve, Pocono Lake, 2035–36 *Patrick* (A-2146–49), 2039 *Patrick* (A-2154); Wier Lake, 2046 *Hodge* (A-2169); Lake Tamaque, 2039 *Hodge* (A-2154). Pike County: 130 *Shulze* (A-2221), 12 *Burke* (A-2204), 14 *Burke* (A-2210).

Eunotia formica Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 414.

This species was rare and may be a contamination.

Monroe County: Mountain Lake, 2051 *Hodge* (A-2178).

Eunotia gracilis (Ehr.) Rabh., 1864, Flora Europaea Algarum, p. 72.
Himantidium gracile Ehr. 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 417. *pl. 2, fig. I, 9; pl. 3, fig. I, 41.*

This species was found only once and then in small numbers.

Pike County: Greeley, 2 *Burke* (A-2188).

Eunotia indica Grun. *apud* Rabh., 1865, Beitrage Näheren Kennt. und Verbreit. des Algen, **2:** 5. *pl. 1, fig. 7.*

This species though found only twice was of frequent occurrence at the spring on Bushkill Creek.

Monroe County: Pocono Lake Preserve, Pocono Lake, 2065 *Patrick* (A-2182). Pike County: Bushkill Creek, 1621 *Shulze* (A-2227).

Eunotia lunaris (Ehr.) Grun. *apud* Van Heurck, 1881, Syn. Diat. Belgique, *pl. 35, figs. 3, 4, 6.*

Synedra lunaris Ehr., 1832, Abhandl. K. Akad. Wiss. Berlin **1831:** 37.

This species is widely distributed. Its most favorable habitats are found in Pike County, particularly Bushkill Creek and Shohola Falls.

Luzerne County: Harvey Lake, 2043 *Hodge* (A-2162). Monroe County: Davy's Run, 2010 *Patrick* (A-2102), 2012–14 *Patrick* (A-2105–09), 2016 *Patrick* (A-2113), 2019 *Patrick* (A-2119); Jaggie's Bog, 262 *Shulze* (A-2223); Mountain Lake, 2051 *Hodge* (A-2178); Lake Tamaque, 2040 *Hodge* (A-2156); Wier Lake, 2046 *Hodge* (A-2168). Pike County: 127–128 *Shulze* (A-2215–17); 2188–90 *Shulze* (A-2233–36); Bushkill Creek, 1621–23 *Shulze* (A-2227–31); Greeley, 1–2 *Burke* (A-2184–88); Shohola Falls, 3–4 *Burke* (A-2190–92), 7 *Burke* (A-2197), 10–14 *Burke* (A-2200–08).

Eunotia lunaris v. **capitata** (Grun.) Hustedt *apud* Pascher, 1930, Süssw. Flora Mitteleurop., Heft 10: 185. *fig. 250.*

Synedra lunaris v. *capitata* Grun., 1862, Verh. Zool. Bot. Ges. Wien **12:** 389.

Pike County: Greeley, 2 *Burke* (A-2188); Bushkill Creek, 1621 *Shulze* (A-2227).

Eunotia Meisteri Hustedt *apud* Pascher, 1930, Süssw. Flora Mitteleurop. Heft 10: 179. *fig. 230.*

Though occurring in several different habitats, this species was only once very frequent and that was in association with *Hypnum* and *Fontinalis*, in Davy's Run.

Monroe County: Davy's Run, 2014–19 *Patrick* (A-2109–19), 2056 *Patrick* (A-2180); Pocono Lake Preserve, Mud Run, 2031 *Hodge* (A-2138); Tobyhanna Creek, 2032–33 *Patrick* (A-2140–42); Wier Lake, 2047 *Hodge* (A-2170). Pike County: Shohola Falls, 3 *Burke* (A-2190), 12–13 *Burke* (A-2205–06).

Eunotia microcephala Krasske, 1932, Hedwigia **72:** 102. *pl. 2, fig. 7.*

This is the same as Van Heurck's concept of *Eunotia tridentula* and *E. tridentula* v. *perminuta*. I have critically examined Van Heurck's Type Slides Nos. 309, 347, and his figures in Synopsis des Diatomées Belgique, *pl. 34, fig. 29, 30. Eunotia tridentula* was first described by Ehrenberg (Abhandl. K. Akad. Wiss. Berlin **1841:** 414. *pl. 2, fig. I, 14*). From Ehrenberg's figure it is clear that it is a larger diatom than the one which Van Heurck had. Therefore Van Heurck's specimens should be considered a misidentification and Krasske's name should be adopted. This species was common in Spring Run.

Monroe County: Davy's Run, 2056 *Patrick* (A-2180); Pocono Lake Preserve, Tobyhanna Creek, 2033 *Patrick* (A-2142); Spring Run, 2037 *C. Myers* (A-2150).

Eunotia monodon Ehr., 1854, Mikrogeologie, *pl. 2, fig. II, 26 a. b.*

This species was only once of frequent occurrence and then in a spring in Bushkill Creek.

Monroe County: Wier Lake, 2046 *Hodge* (A-2169); Jaggie's Bog, 263 *Shulze* (A-2225). Pike County: 128 *Shulze* (A-2217); Bushkill Creek, 1621 *Shulze* (A-2227).

Eunotia monodon v. **major** (W. Sm.) Hustedt *apud* Pascher, 1930, Süssw. Flora Mitteleurop., Heft 10: 186.

Himantidium majus W. Sm., 1856, Brit. Diat., **2:** 14. *pl. 33, fig. 286.*

This species was present in several habitats, but was very frequent or common in only two, Wier Lake and Mountain Lake. In both instances it was found in association with surface littoral vegetation.

Monroe County: Davy's Run, 2056 *Patrick* (A-2180); Pocono Lake Preserve, Pocono Lake, 2035 *Patrick* (A-2146); Wier Lake, 2046 *Hodge* (A-2168); Mountain Lake, 2051 *Hodge* (A-2178). Pike County: 2188–90 *Shulze* (A-2234–36); Shohola Falls, 4 *Burke* (A-2192), 11–12 *Burke* (A-2202–04), 14 *Burke* (A-2209). Wayne County: Angels, 2023 *Burke* (A-2127).

Eunotia Naegelii Migula, 1907, Kryptogamen Flora, **2:** 203.

This species is sometimes called *Eunotia alpina* (Naeg.) Hustedt. The name *alpina* in the genus *Eunotia* is preoccupied by a species of Kützing, and therefore cannot be used for this species which when first named was in the genus *Synedra.*

From this study, it seems that this species prefers definitely distrophic, acid water. It was of very frequent occurrence in Lake Tamaque and Lost Lake.

Monroe County: Lost Lake, 2020 *Turner* (A-2121); Lake Tamaque, 2039–40 *Hodge* (A-2154–56). Pike County: Shohola Falls, 12 *Burke* (A-2205).

Eunotia pectinalis (Dillw.) Rabh., 1864, Flora Europea Algarum, p. 73.

Conferva pectinalis Dillw., 1809, Brit. Conf., p. 43. *pl. 24.*

From this study it seems that this species prefers moving water. It was very frequent in Davy's Run, at the spring in Bushkill Creek, and on dripping rocks at Shohola Falls.

Monroe County: Davy's Run, 2019 *Patrick* (A-2119), 2056 *Patrick* (A-2180); Pocono Lake Preserve, Pocono Lake, *F. Myers* (A-2213); Tobyhanna Creek, 2032 *Patrick* (A-2140); Wier Lake, 2046 *Hodge* (A-2169). Pike County: 2188–90 *Shulze* (A-2233–36); Bushkill Creek, 1621 *Shulze* (A-2227); Shohola Falls, 3–4 *Burke* (A-2190–92), 14 *Burke* (A-2208).

Eunotia pectinalis v. **minor** (Kütz.) Rabh., 1864, Flora Europaea Algarum, p. 74.

Himantidium minus Kütz., 1844, Bacill. p. 39. *pl. 16, fig. 10, 1–4.*

Though found in several localities this species was very frequent only in Davy's Run.

Monroe County: Davy's Run, 2018–19 *Patrick* (A-2118–19), 2056 *Patrick* (A-2180); Lost Lake, 2025 *Turner* (A-2131); Pocono Lake Preserve, Tobyhanna Creek, 2032–33 *Patrick* (A-2140–42); Wier Lake, 2046 *Hodge* (A-2168); Mountain Lake, 2051 *Hodge* (A-2178). Pike County: 127 *Shulze* (A-2215); Bushkill Creek, 1623 *Shulze* (A-2231); Shohola Falls, 4 *Burke* (A-2192).

Eunotia pectinalis v. **minor** f. **impressa** (Ehr.) Hustedt *apud* Pascher, 1930, Süssw. Flora Mitteleurop., Heft 10: 182.

Eunotia impressa Ehr., 1854, Mikrogeologie, *pl. 3, fig. IV, 20*; *pl. 14, fig. 66.*

This form was very frequent in one locality designated as Pike County. Krieger (1929) states it is found in pH 4.5–5.5.

Monroe County: Pocono Lake Preserve, Spring Run, 2037 *Myers* (A-2150); Pocono Lake, 2038 *Patrick* (A-2152), 2065 *Patrick* (A-2182). Pike County: 2188–90 *Shulze* (A-2233–36); Bushkill Creek, 1623 *Shulze* (A-2231); Greeley, 1–2 *Burke* (A-2184–88); Lake Wallenpaupek tributary, 5 *Burke* (A-2195); Shohola Falls, 13 *Burke* (A-2206).

Eunotia pectinalis v. **recta** Rabh. *ex* Mayer, 1917, Denks. K. Bayer. Bot. Ges. **13** (n.s. **7**): *pl. 1, figs. 37, 38.*

Mayer gives no description and I have not been able to find the description of Rabenhorst. Therefore I am supplying the following Latin description.

Valvae lenes arcuatae 19–20 μ longae, 3 μ latae, apicibus linibus rotundis; striis 15–16 in 10 μ.

This variety was rare and found in only one locality.

Monroe County: Davy's Run, 2016 *Patrick* (A-2113).

Eunotia pectinalis v. **undulata** (Ralfs) Rabh., 1864, Flora Europaea Algarum, p. 74.

Fragilaria pectinalis v. *undulata* Ralfs, 1843, Ann. Mag. Nat. Hist. **12:** 108. *pl. 2, fig. 3d.*

Ralfs refers to Pritchard, 1841, A History of the Infusoria, p. 220. *fig. 171.* I have looked up this reference and find that the species being considered is listed under the name *Fragilaria grandis.*

This species though found in several habitats was common only in Bushkill Creek and at Shohola Falls from moss in swift water at the top and in scrapings from dripping rocks at Shohola Falls.

Monroe County: Davy's Run, 2016 *Patrick* (A-2113), 2019 *Patrick* (A-2119); Mountain Lake, 2051 *Hodge* (A-2178); Pocono Lake Preserve, Mud Run, 2031 *Hodge* (A-2138); Pocono Lake, 2034–36 *Patrick* (A-2144–48), 2038 *Patrick* (A-2152), 2065 *Patrick* (A-2182), *F. Myers* (A-2213); South Pocono Lake, 2010 *Patrick* (A-2101); Tobyhanna Creek, 2032 *Patrick* (A-2140). Pike County: 262 *Shulze* (A-2223); Bushkill Creek, 1621 *Shulze* (A-2227); Shohola Falls, 3 *Burke* (A-2190), 4 *Burke* (A-2193), 10 *Burke* (A-2200), 12 *Burke* (A-2204), 14 *Burke* (A-2210).

Eunotia praerupta Ehr., 1841, Ber. K. Akad. Wiss. Berlin **1841:** 143, 204.

This species was found only once and then it was rare.

Pike County: Greeley, 2 *Burke* (A-2188).

Eunotia praerupta v. **bidens** (Ehr.) Grun., 1880, K. Sv. Vet. Akad. Handl. **17** (2): 109.

Eunotia bidens Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 413.

Hustedt states that Ehrenberg's identification is doubtful, so he uses W. Smith's *Himantidium bidens* as the basis for the name *bidens*. W. Smith, however, gives Ehrenberg as the authority for the name *Himantidium bidens*, and refers to Kützing's "Species Algarum," p. 9. Kützing refers to Ehrenberg in Abhandl. K. Akad. Wiss. Berlin, **1841:** 413 where he states that *Himantidium bidens* equals *Eunotia bidens*, which is described in the reference given above.

This species was found only in Pike County. In the Greeley habitats it was associated with either *Fontinalis* or *Sphagnum*. In one collection, 2188 Shulze, specimens were found with spines on the dorsal margin of the valve.

Pike County: 129 *Shulze* (A-2219), 2188 *Shulze* (A-2234); Bushkill Creek, 1621 *Shulze* (A-2227); Greeley, 1–2 *Burke* (A-2184–88).

Eunotia praerupta v. **curta** Grun. *apud* Van Heurck, 1881, Syn. Diat. Belgique, *pl. 34, fig. 24.* (in the text, 1885, Van Heurck refers to this as forma *curta*).

This variety is rare in each of the localities.

Pike County: Greeley, 2 *Burke* (A-2188); Shohola Falls, 12 *Burke* (A-2204).

Eunotia praerupta v. **inflata** Grun. *apud* Van Heurck, 1881, Syn. Diat. Belgique, *pl. 34, fig. 17*, text (1885) p. 143.

Pike County: Greeley, 1 *Burke* (A-2184).

Eunotia robusta Ralfs *apud* Pritchard, 1861, A History of the Infusoria, p. 763.

Unless, as I have previously suggested, De Toni's "Sylloge Algarum" is taken as a starting point for diatoms, this name, according to the International Rules of Botanical Nomenclature section 10, article 56, will have to be discarded.

In this study, the species was typically found in acid water. It reached its best development in Lost Lake which is strongly distrophic, and in South Pocono Lake in association with *Sphagnum*.

Monroe County: Lost Lake, 2020 *Turner* (A-2121); Pocono Lake Preserve, South Pocono Lake, 2010–11 *Patrick* (A-2101–03); Tobyhanna Creek, 2032–33 *Patrick* (A-2140–42); Pocono Lake, 2034–35 *Patrick* (A-2144–47), 2065 *Patrick* (A-2182), *F. Myers* (A-2213). Pike County: 128–29 *Shulze* (A-2217–19), 2188–90 *Shulze* (A-2234–36); Bushkill Creek, 1621 *Shulze* (A-2227); Greeley, 1 *Burke* (A-2184); Shohola Falls, 12 *Burke* (A-2204).

Eunotia rostellata Hustedt. This species was invalidly described by Hustedt, 1913, in A. Schmidt's Atlas der Diatomaceen-Kunde, *pl. 289, figs. 3, 4.* I have therefore included a Latin description.

Valvae arcuatae 46 μ longae, 4–5 μ latae, dorsali et ventrali lateribus prope parallelis; striis 14–17 in 10 μ.

I have checked my specimens with those of H. L. Smith, Spec. Typicae no. 160 which are from the type locality, and they seem to be the same. The striae usually vary from 14–15 in 10 μ at the center of the valve to 17 in 10 μ at the ends.

Pike County: 2189 *Shulze* (A-2235).

Eunotia septena Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 414. *pl. 4, fig. II, 13.*

It would perhaps be wise to unite several of these species of Ehrenberg as Ralfs and Grunow have done. If this is done, however, according to the International Rules of Botanical Nomenclature, one of Ehrenberg's names must be retained, as any additional name would be superfluous.

This species was rare in one locality.

Pike County: 127–30 *Shulze* (A-2215–21).

Eunotia septentrionalis Oestrup, 1897, Meddl. om Grönld. **15:** 274. *pl. 1, fig. 10.*

This species occurred typically in acid water. It reached its best development in association with moss in running water and was very frequent in *Sphagnum* in the swamp at Greeley, and of frequent occurrence in Davy's Run and Mud Run.

Monroe County: Davy's Run, 2014 *Patrick* (A-2109), 2019 *Patrick* (A-2119); Pocono Lake Preserve, Mud Run, 2031 *Hodge* (A-2138). Pike County: 2188 *Shulze* (A-2233), 128 *Shulze* (A-2217); Greeley, 1–2 *Burke* (A-2184–88); Shohola Falls, 3 *Burke* (A-2190), 14 *Burke* (A-2208).

Eunotia sudetica O. Müll., 1898, Forschungsber. Biol. Stat. Plön **6:** 59. *pl. 3, figs. 25, 26.*

Monroe County: Wier Lake, 2046 *Hodge* (A-2168).

Eunotia suecica A. Cleve, 1895, Bihang K. Sv. Vet. Akad. Handl. **21** Afd. 3 (2): 29, *pl. 1, figs. 31, 32.*

This species occurred only once and then it was rare.

Pike County: Shohola Falls, 9 *Burke* (A-2198).

Eunotia tautonensis Hustedt.

This species, lacking any kind of description, is invalidly described by Hustedt, 1913, in A. Schmidt's Atlas Diatomaceen-Kunde, *pl. 291, figs. 1–3.*

Valvae arcuatae elongatae, 94–257 μ longae, 5–10 μ latae, lateribus parallelis, apicibus cuneatis; striis 12–17 in 10 μ.

As in *Eunotia flexuosa* the terminal nodules are distinct, and at one end of the valve there is a jelly pore. The striae vary from 12–14 in 10 μ in the center of the valve to 17 in 10 μ at the end of the valve. Some of the specimens from Lost Lake, where the species was very frequent, had small spines

on the dorsal margin. However, this was not typically the case. No doubt this species is near to the genus *Desmogonium*.

Monroe County: Lost Lake, 2020 *Turner* (A-2121); Pocono Lake Preserve, Pocono Lake, *F. Myers* (A-2213).

Eunotia tenella (Grun.) Hustedt *apud* Pascher, 1930, Süssw. Flora Mitteleurop., Heft 10: 175. *fig. 220.*

Eunotia arcus v. *tenella* Grun. *apud* Van Heurck, 1881, Syn. Diat. Belgique, *pl. 34, figs. 5, 6.*

PLATE I, FIG. 1

This species was first invalidly described by Hustedt, 1913, A. Schmidt's Atlas Diatomaceen-Kunde, *pl. 287, figs. 20–25.*

A small form of this species which corresponds to Hustedt's illustration in A. Schmidt's Atlas Diatomaceen-Kunde, *pl. 287, fig. 25*, was also found. It is 9.3 μ long, 3.5 μ wide, and the striae are 17 in 10 μ. As it is quite different in shape from the usual *E. tenella*, I have illustrated it.

This species was very frequent in the swamp at Greeley.

Monroe County: Davy's Run, 2016 *Patrick* (A-2113), 2018–19 *Patrick* (A-2118–19); Pocono Lake Preserve, Mud Run, 2031 *Hodge* (A-2138). Pike County: 2188 *Shulze* (A-2234); Bushkill Creek, 1623 *Shulze* (A-2231); Greeley, 2 *Burke* (A-2188).

Eunotia trinacria Krasske, 1929, Bot. Arch. **27:** 349. *fig. 1.*

This species was present in only two habitats.

Monroe County: Davy's Run, 2017 *Patrick* (A-2115). Pike County: Greeley, 2 *Burke* (A-2188).

Eunotia valida Hustedt *apud* Pascher, 1930, Süssw. Flora Mitteleuropas. Heft 10: 178. *fig. 229.*

This species was rare in one habitat where it might have been a contamination from some other habitat.

Pike County: 130 *Shulze* (A-2221).

Eunotia veneris (Kütz.) De Toni, 1891, Sylloge Algarum, **2:** 794.

Himantidium veneris Kütz., 1844, Bacill. p. 40. *pl. 30, fig. 7.*

In 1854 Gregory (Quart. Jour. Micros. Sci. **2:** 96) describes a diatom which he states W. Smith has named *Eunotia incisa*. He states that he has sent some of these specimens to Kützing who replied that they were different from *Himantidium veneris*. Gregory further states that his species is very similar in shape to *H. veneris*, but that *H. veneris* does not have the notches close to the terminal puncta nor does it have striae as *Eunotia incisa* does. Obviously, if it belongs to the genus *Himantidium*, it has striae. As for the notches to which Gregory refers, they are the terminal nodules. I find that by careful focusing, this notch can be shown to appear and disappear. Unfortunately I have not seen any authenticated specimens of either Kützing or Gregory.

In some cases specimens were found with obtuse ends as Gregory shows as variety β. The striae in some of my specimens were coarser than is usually found in *E. veneris*. They were in some cases as few as 12 in 10 μ. Perhaps these forms should be separated as varieties.

This species was very frequent at Shohola Falls in a collection made from a dripping wall and in a collection from algae and moss in the brook. It was common in squeezings from plants (*Elodea*, *Myriophyllum*, etc.) in shallow water in Pocono Lake and Lake Popomoning, and in Spring Run.

It is interesting to note that this species reached such good development in two habitats which were quite diverse in some respects. Pocono Lake has an average pH of 6.4. Analysis of the water shows calcium 2.37 p.p.m., and bicarbonates 15.6 p.p.m. Popomoning Lake has a pH of 8–8.1, calcium 8.82 p.p.m., and bicarbonates 33.6–34.2 p.p.m. In Pocono Lake the specimens had rounded ends, and striae about 14 in 10 μ. In Lake Popomoning the specimens had acute apices and striae 17–20 in 10 μ. Krieger (1929) states that this species is found in pH 4.5–5.5, which is lower than either of these two habitats.

Luzerne County: Harvey Lake, 2042 *Hodge* (A-2160). Monroe County: Davy's Run, 2015–16 *Patrick* (A-2111–13), 2018 *Patrick* (A-2118); Pocono Lake Preserve, Mud Run, 2031 *Hodge* (A-2138); Pocono Lake, 2034–37 *Patrick* (A-2144–50), 2065 *Patrick* (A-2182); Tobyhanna Creek, 2032–33 *Patrick* (A-2140–42); Popomoning Lake, 2045 *Hodge* (A-2166). Pike County: 2188 *Shulze* (A-2233); Bushkill Creek, 1623 *Shulze* (A-2231); Greeley, 2 *Burke* (A-2188); Shohola Falls, 3 *Burke* (A-2190), 10–14 *Burke* (A-2200–09). Wayne County: Angels, 2021 *Burke and Patrick* (A-2123).

COCCONEIS (EHR.) CLEVE

Cocconeis placentula Ehr., 1838, Die Infusionsthierchen als volkommene Organismen, p. 194.

This species was of common or very frequent occurrence at Raymondskill Falls, Harvey Lake, Popomoning Lake, and Mountain Lake.

Luzerne County: Harvey Lake, 2042 *Hodge* (A-2160). Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131); Popomoning Lake, 2045 *Hodge* (A-2166); Mountain Lake, 2051 *Hodge* (A-2178). Northampton County: Green Pond, 2050 *Hodge* (A-2177). Pike County: Shohola Falls, 10–11 *Burke* (A-2201–02); Lake Wallenpaupek tributary, 5 *Burke* (A-2195); Bushkill Creek, 1623 *Shulze* (A-2231). Wayne County: Angels, 2021–22 *Burke and Patrick* (A-2124–25).

Cocconeis placentula v. **lineata** (Ehr.) Cl., 1895, K. Sv. Vet. Akad. Handl. **27** (3): 169.

Cocconeis lineata Ehr. is first mentioned by Ehrenberg, Abhandl. K. Akad. Wiss., **1841,** p. 369, but is neither described nor illustrated. It is first illustrated, I believe, in his Passat-Staub und Blut-Regen, Abhandl. K. Akad. Wiss. Berlin **1847,** and published separately in 1849, where it appears on *pl. 5, I, fig. 10.*

This variety was very frequent at Shohola Falls and at Angels. In both these cases it was found attached to stones in shallow swift water.

Monroe County: Popomoning Lake, 2045 *Hodge* (A-2166); Wier Lake, 2047 *Hodge* (A-2170). Pike County: Shohola Falls, 4 *Burke* (A-2192). Wayne County: Angels, 2026 *Burke and Patrick* (A-2134).

ACHNANTHES BORY

Cleve has divided this genus into several genera. Hustedt prefers to use Cleve's names to indicate subgenera or groups rather than to split the genus into several genera. Since Hustedt's arrangement is the one most generally used today, and until I have studied the genus more critically, I shall follow it. On this basis three groups are recognized in this study.

A. Transverse rows composed of very coarse punctae, the pseudoraphe usually excentric. See A′ and A″. ..... **Achnanthidium**

A′. Transverse rows composed of very fine punctae, the pseudoraphe central. **Microneis**

A″. Transverse rows composed of a double row of punctae..... **Achnanthes**

ACHNANTHES subgenus

Achnanthes coarctata (W. Sm.) Grun. *apud* Cl. and Grun., 1880, K. Sv. Vet. Akad. Handl. **17** (2): 20.

Achnanthidium coarctatum W. Sm., 1855, Ann. Mag. Nat. Hist. 2nd Ser. **15:** 8, *fig. 10.*

W. Smith cites Brebisson as the authority and gives as reference Kütz. Spec. Algarum, p. 54. This is not a correct reference and I cannot find that Brebisson ever published such a name.

The only habitat in which this species was found, was on the surfaces of dripping rocks which were outcrops of limestone.

Pike County: Shohola Falls, 15 *Burke* (A-2211), 9 *Burke* (A-2198).

MICRONEIS subgenus

A. Rapheless valve with a horseshoe-shaped area well-developed on one side of the middle of the valve. See A′ and A″.

B. Valve with raphe with the striae irregularly longer and shorter in the central area, more numerous on valve with raphe than on rapheless valve

C. Valve elliptic with attenuate rostrate ends ....**A. Peragalli**

C. Valve elliptic but ends usually rounded, not as above **A. Oestrupii** var.

B. Not as above, striae about the same number on both valves **A. lanceolata** and vars.

A′. Rapheless valve with striae broken so as to form a longitudinal line on each side of the pseudoraphe .....**A. Lewisiana**

A″. Rapheless valve without horseshoe-shaped area or longitudinal lines

D. Valve with raphe with a well-developed stauros reaching to the edges of the valve

E. Stauros on one side of raphe having an area which appears to be raised, thus giving the stauros on that side a bifurcate appearance **A. hungarica**

E. Stauros having the same appearance on both sides of the central nodule **A. exigua**

D. Valve with raphe with or without a stauros, if present not reaching to edges of valve, striae fine, over 20 in 10 μ

F. Valve linear ..... **A. linearis**

F. Valve with capitate-rostrate ends, striae usually slightly more distantly spaced at center of valve around central nodule **A. microcephala**

F. Hard to distinguish from the above, but ends usually rounded or somewhat rostrate, not capitate, striae not more distant at central nodule **A. minutissima**

Achnanthes exigua Grun. *apud* Cl. and Grun., 1880, K. Sv. Vet. Akad. Handl. **17** (2): 21.

This species was found only once and then it was rare.

Monroe County: Popomoning Lake, 2045 *Hodge* (A-2166).

Achnanthes hungarica Grun. *apud* Cl. and Grun., 1880, K. Sv. Vet. Akad. Handl. **17** (2): 20.

Achnanthidium hungaricum Grun., 1863, Verh. Zool. Bot. Ges. Wien, **13:** 146.

This species was only found once and then it was rare. It is characterized by the fact that the stauros appears to be bifurcate on one side of the central nodule, but close examination shows that this is not true.

Monroe County: Mountain Lake, 2051 *Hodge* (A-2178).

Achnanthes lanceolata (Bréb.) Grun. *apud* Cl. and Grun., 1880, K. Sv. Vet. Akad. Handl. **17** (2): 23.

Achnanthidium lanceolatum Bréb. *ex* Kützing, 1849, Spec. Algarum, p. 54.

This species was very frequent in the shallow water of a small tributary of Mill Creek, from the surface of leaves of a very small puddle near Mill Creek, enmeshed in moss in the swift water of Mill Creek, and in the surface scum on rocks in Raymondskill Falls.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131); Mountain Lake, 2051 *Hodge* (A-2178). Northampton County: Green Pond, 2050 *Hodge* (A-2177). Pike County: Shohola Falls, 3 *Burke* (A-2190), 15 *Burke* (A-2211), 5 *Burke* (A-2195). Wayne County: Angels, 2021–24 *Burke and Patrick* (A-2124–29).

Achnanthes lanceolata var. **apiculata** var. nov.

PLATE I, FIGS. 4, 5

Valvae elliptico-lanceolatae, 28 μ longae, 10–11 μ latae, apicibus apiculatis. Valva superior ad instar soleae equinae effigiem in medio ostendens, pseudoraphe anguste lanceolata; striis radiantibus, 10–12 in 10 μ. Valva inferior aream axialem angustam et aream centralem rotundatam exhibens; striis validis radiantibus, 10 in 10 μ. **Type:** Shohola Falls, 3 *Burke* (A-2190).

A noteworthy feature of this diatom is that the valve with a raphe has much more strongly radiate striae than the valve without a raphe. It dif-

fers from *A. lanceolata* v. *robusta* in that the ends are more apiculate than in *robusta* and the axial area is narrower and not granular.

This diatom was only found in one geographical habitat, Shohola Falls, but it was well distributed in the various ecological habitats here.

Pike County: Shohola Falls; 3 *Burke* (A-2190), 10–14 *Burke* (A-2201–10).

Achnanthes lanceolata v. **rostrata** Hust. *apud* Pascher, 1930, Süssw. Flora Mitteleurop., Heft 10: 208. *fig. 306b.*

In this study this variety was only found in running water. It was very frequent in the surface scum on rocks in little pools in Raymondskill Falls.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: Shohola Falls, 10–11 *Burke* (A-2200–02); Lake Wallenpaupek tributary, 5 *Burke* (A-2195). Wayne County: Angels, 2026 *Burke and Patrick* (A-2134).

Achnanthes Lewisiana sp. nov.

PLATE I, FIGS. 2, 3

Valvae lineari-ellipticae, 15 μ longae, 4.6 μ latae. Valva superior pseudoraphem distinctam exhibens; striis 15–17 in 10 μ; utrimque per lineam longitudinalem interruptis. Valva inferior aream axialem ad valvae ipsae ¼–⅓ latitudinem prope nodulum centralem exhibens; area centrale nulla; striis parum radiantibus, 15–17 in 10 μ. **Type:** Shohola Falls, 14 *Burke* (A-2210).

This diatom is named in honor of Dean Ivey F. Lewis with whom I did my graduate work at the University of Virginia.

This species is particularly characterized by the interrupted striae on the rapheless valve. The most closely related fresh water species is *A. Suchlandti* Hustedt. The resemblance of my specimen to this species is mainly in the interrupted striae of the rapheless valve, for it differs from it in shape of axial area, number of striae, and size.

Both valves were seen and drawn from the same frustule.

Pike County: Greeley, 2 *Burke* (A-2188); Shohola Falls, 14 *Burke* (A-2208, 2210).

Achnanthes linearis (W. Sm.) Grun. *apud* Cl. and Grun., 1880, K. Sv. Vet. Akad. Handl. **17** (2): 23.

Achnanthidium lineare W. Sm., 1855, Ann. Mag. Nat. Hist. 2d ser. **15:** 8. *pl. 1, fig. 9.*

Though found in a great many habitats, this species was common or very frequent only in Davy's Run. It was found in association with moss, particularly *Fontinalis*, in running water.

Monroe County: Davy's Run, 2017 *Patrick* (A-2115), 2019 *Patrick* (A-2119), 2056 *Patrick* (A-2180); Pocono Lake Preserve, 2031 *Hodge* (A-2138), 2032 *Patrick* (A-2140), 2065 *Patrick* (A-2182). Luzerne County: Harvey Lake, 2042 *Hodge* (A-2160). Pike County: Shohola Falls, 10–14 *Burke* (A-2200–09).

Achnanthes microcephala (Kütz.) Grun. *apud* Cl. and Grun., 1880, K. Sv. Vet. Akad. Handl. **17** (2): 22.

Achnanthidium microcephalum Kütz., 1844, Bacill., p. 75. *pl. 3, figs. 13, 19.*

Luzerne County: Harvey Lake, 2042 *Hodge* (A-2160). Monroe County: Trout Lake, 2049 *Hodge* (A-2174).

Achnanthes minutissima Kütz., 1844, Bacill., p. 75. *pl. 13, fig. 2c.*

This species was found only once and then it was rare.

Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195).

Achnanthes minutissima v. **cryptocephala** Grun. *apud* Van Heurck, 1880, Syn. Diat. Belgique, *pl. 27, figs. 41–44.*

Monroe County: Pocono Lake Preserve, Tobyhanna Creek, 2032–33 *Patrick* (A-2140–42).

Achnanthes Oestrupii v. **parvula** var. nov.

PLATE I, FIGS. 6, 7

Valvae ellipticae apicibus parum rostratis, 12 μ longae, 6 μ latae. Valva superior spatium hyalinum et in latere uno effigiem ad instar soleae equinae ostendens; striis parum radiantibus 15–16 in 10 μ. Valva inferior aream axialem angustam et aream centralem transversam exhibens; striis 28 in 10 μ, radiantibus, longis inaequaliter et ad nodulum centralem crassis. **Type:** Shohola Falls, 14 *Burke* (A-2209).

This variety differs from the species in that it is consistantly smaller in size. It also differs from the original description of the species in the number of striae of the rapheless valve. This species was first noted by Oestrup and considered a variety of *A. lanceolata*. A. Cleve (Acta Forst. Fenn. **22:** 53) first named it *A. lanceolata* v. *Oestrupii*. The illustrations of both authors indicate the striae number of the rapheless valve as 10–12 in 10 μ. Hustedt raised the variety to specific rank, and states the striae number of the rapheless valve is "10–14 (measuring on the edge of the short striae forms) or 14–18 (measuring on the pseudoraphe of the longer striated forms)." My specimens have striae 15 in 10 μ whether measured at margin or inner edge of striae.

Both valves were seen on the same frustule.

Pike County: Shohola Falls, 10, 14 *Burke* (A-2200, 2209).

Achnanthes Peragallii Brun and Herib. *apud* Herib., 1893, Diat. Auvergne, p. 50. *pl. 1, fig. 4.*

This species was rare in the two localities where it was found. In both cases it was in running water.

Pike County: Shohola Falls, 10 *Burke* (A-2200); Lake Wallenpaupek tributary, 5 *Burke* (A-2195).

ACHNANTHES subgenus

Achnanthes Stewartii sp. nov.

PLATE II, FIGS. 1–3

Valvae ellipticae, 16 μ longae, 7.5 μ latae, area axiali angusta, costis tenuibus 14 in 10 μ, serie duplici punctorum parvorum interpositu. **Type:** Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2194).

This species is named in honor of Dr. Thomas S. Stewart, Curator of the Microscopic Department of the Academy of Natural Sciences of Philadelphia, who has kindly made most of the photographs of diatoms which I have published.

It is with some hesitation that I put this species in this subgenus. The costae are not very pronounced, but the presence of a double row of punctae between each two costae places it here.

This species was only found in one locality, but as it is a very distinct species and of frequent occurrence I have described it.

Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2194–95).

AMPHIPLEURA KÜTZING

Amphipleura pellucida Kützing, 1844, Bacill., p. 103. *pl. 3, fig. 52.*
Frustulia pellucida Kütz., 1833, Linnaea, **1833:** 543. *pl. 13, fig. 11.*

This species seems to prefer circum-neutral waters. It was found only once in this study.

Luzerne County: Harvey Lake, 2043 *Hodge* (A-2162).

VANHEURCKIA BRÉBISSON

The name *Frustulia*, sometimes applied to this genus, is invalid according to the International Rules of Botanical Nomenclature.

Vanheurckia rhomboides (Ehr.) Bréb., 1869, Ann. Soc. Phy. Mic. Belge **1:** 204.
Navicula rhomboides Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 419. *pl. 3, fig. I, 15.*

This species was very frequent in Lost Lake which is a strongly distrophic lake which contains a great deal of *Sphagnum*. It is found only in acid water, and usually in association with moss.

Lackawanna County: Indian Lake, 2044 *Hodge* (A-2164). Monroe County: Lost Lake, 2020 *Turner* (A-2121); Pocono Lake Preserve, Pocono Lake, *F. Myers* (A-2213); South Pocono Lake, 2010–11 *Patrick* (A-2101–03). Pike County: Shohola Falls, 11 *Burke* (A-2202).

Vanheurckia rhomboides v. **amphipleuroides** (Grunow)
Navicula rhomboides v. *amphipleuroides* Grun. *apud* Cl. and Grun., 1880, K. Sv. Vet. Akad. Handl. **17** (2): 47. *pl. 3, fig. 59.*

Grunow places this species in the group *Vanheurckia* under the genus *Navicula*.

This variety was found in shallow running water and was very frequent in a shallow tributary of Mill Creek. It was not found in the standing, strongly distrophic waters of some of the habitats studied.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: Bushkill Creek, 1623 *Shulze* (A-2231); Lake Wallenpaupek tributary, 5 *Burke* (A-2195). Wayne County: Angels, 2021–22 *Burke and Patrick* (A-2124–25), 2026 *Burke and Patrick* (A-2134).

Vanheurckia rhomboides v. **crassinervia** (Bréb.) Van Heurck, 1881, Syn. Diat. Belgique, *pl. 17, figs. 4–5*, text (1885) p. 112.

Navicula crassinervia Bréb. *apud* W. Sm., 1853, Brit. Diat., **1:** 47.

Brébisson (Ann. Soc. Phy. Mic. Belge **1:**204) later transferred this species to the genus *Vanheurckia*.

This variety is the same as the invalidly published *Frustulia rhomboides* v. *saxonica* (Rabh.) De Toni.

This variety was well distributed in the more acid waters of this region and was of common occurrence in Davy's Run, Lost Lake, Pocono Lake, and Lake Tamaque.

Lackawanna County: Indian Lake, 2044 *Hodge* (A-2165). Monroe County: Davy's Run, 2013–15 *Patrick* (A-2107–11), 2018–19 *Patrick* (A-2117-19), 2056 *Patrick* (A-2180); Lost Lake, 2020 *Turner* (A-2121); Pocono Lake Preserve, Pocono Lake, 2034–38 *Patrick* (A-2144–52), 2065 *Patrick* (A-2182); Mud Run, 2031 *Hodge* (A-2138); South Pocono Lake, 2011–12 *Patrick* (A-2104–05); Tobyhanna Creek, 2032–33 *Patrick* (A-2140–42); Lake Tamaque, 2039–40 *Hodge* (A-2154–56). Pike County: 2188–90 *Shulze* (A-2234–36); Greeley, 2 *Burke* (A-2188); Shohola Falls, 4 *Burke* (A-2193), 10 *Burke* (A-2200), 12 *Burke* (A-2204), 14 *Burke* (A-2210).

Vanheurckia rhomboides v. **crassinervia** f. **capitata** comb. nov.

This form is the same as the invalidly published *Frustulia rhomboides* v. *saxonica* f. *capitata* (Mayer) Hustedt.

Valvae elliptico-lanceolatae, ca. 45 μ longae; apicibus rostrato-capitatis; striis subtilissimis, 34–36 in 10 μ.

This form is characterized by its capitate-rostrate ends. It is usually about 45 μ long.

This form was common in Pocono Lake from squeezings of *Eleocharis*, *Dicranum*, and *Hypnum* growing in one foot of water and was very frequent in scrapings of piles supporting the Emlen Dock in Pocono Lake. These two habitats were within fifty yards of each other.

Monroe County: Davy's Run, 2016 *Patrick* (A-2113); Mountain Lake, 2051 *Hodge* (A-2178); Pocono Lake Preserve, Pocono Lake, 2035–36 *Patrick* (A-2147–48), 2065 *Patrick* (A-2182); Tobyhanna Creek, 2032–33 *Patrick* (A-2140–42); South Pocono Lake, 2010 *Patrick* (A-2101). Pike County: Bushkill Creek, 1623 *Shulze* (A-2231); Shohola Falls, 3–4 *Burke* (A-2190–92), 11 *Burke* (A-2202), 14 *Burke* (A-2208).

Vanheurckia vulgaris (Thw.) Van Heurck, 1880, Syn. Diat. Belgique, *pl. 17, fig. 6*, text (1885) p. 112.

Colletonema vulgaris Thw., 1848, Ann. Mag. Nat. Hist. 2d ser. **1**, *pl. 12.*

This species was found in several localities but was rare in each case. It was usually found in running water.

Monroe County: Davy's Run, 2015 *Patrick* (A-2111); Wier Lake, 2047 *Hodge* (A-2171); Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: 2189 *Shulze* (A-2235); Shohola Falls, 4 *Burke* (A-2192), 14 *Burke* (A-2208). Wayne County: Angels, 2021 *Burke and Patrick* (A-2124), 2026 *Burke and Patrick* (A-2134).

CALONEIS CLEVE

Caloneis Lewisii sp. nov.

PLATE II, FIG. 4

Valvae bis constrictae longae 27 μ ad medium 8.7 μ apicibus cuneatae; striis transversis 19–20 in 10 μ; area axiali angusto, nodulo centrali majusculo subquadrangularis signis lunatis duobus crasso. **Type:** Illinois, Du Page County, 2423 *F. Drouet, P. C. Standley and J. A. Steyermark* (A-2018).

It is regrettable that the often used name, *Caloneis trinodis*, cannot be retained for this species. *Caloneis trinodis* is based upon the specimens of Lewis. Lewis misidentified his specimens as *Navicula trinodis* W. Sm. I have conferred with Dr. E. D. Merrill and Dr. Francis W. Pennell about using the name *Caloneis trinodis*, but they assure me that since this species is based upon the misidentification of Lewis, this cannot be done. In 1878 Grunow, apparently unaware of Lewis' specimens, called this species *Navicula Trochus* var.? *biconstricta*. Unfortunately the name *biconstricta* is preoccupied in the genus *Caloneis*. Thus it seems that the best thing to do is to name the species after Lewis who found the first specimens. I do not believe it correct to consider it a variety of *Caloneis Schumanniana* as Cleve (K. Sv. Vet. Akad. Handl. **26** (2): 53) and Reichelt (Archiv Hydrobiol. Planktonk. **1:** 231–32) have done.

In my recent paper (Proc. Acad. Nat. Sci. **95:** 71) I have given Boyer the credit for the name *Caloneis trinodis*. This was a mistake as Meister first made the combination in 1912. However, as shown above, this name is invalid.

Northampton County: Green Pond, 2050 *Hodge* (A-2176).

Caloneis silicula v. **alpina** Cl., 1893, K. Sv. Vet. Akad. Handl. **26** (2): 51.

It is very interesting to find this variety in the Pocono Plateau. The identification of the variety has been checked with Cleve and Möller type no. 273. Hustedt stated that this variety is only found in the high mountains of Europe.

In this study, the diatom was found only once, and then it was rare. From this I would infer that Davy's Run is not the ideal habitat, and the specimens which I found might be contaminations brought in by birds, etc. from some other habitat.

Monroe County: Davy's Run, 2014 *Patrick* (A-2110).

NEIDIUM PFITZER

A. Striae more than 20 in 10 μ
  B. Ends of valve rounded, not at all constricted
    C. Sides of valve parallel ..... **N. bisulcata**
    C. Sides of valve undulate ..... **N. bisulcata v. undulata**
  B. Ends of valve more or less constricted, from slightly rostrate to protracted rostrate ends
    D. Ends of valve only slightly constricted **N. affine**
    D. Ends of valve distinctly protracted and rostrate **N. affine v. amphirhynchus**
A. Striae less than 20 in 10 μ
  E. Valves linear
    F. Ends rounded ..... **N. iridis f. vernalis**
    F. Ends wedge shaped ..... **N. iridis v. amphigomphus**
  E. Valves linear-lanceolate
    G. Ends rounded ..... **N. iridis**
    G. Ends subrostrate ..... **N. iridis v. ampliata**

Neidium affine (Ehr.) Cl., 1894, K. Sv. Vet. Akad. Handl. **26** (2): 69.
Navicula affinis Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 417. *pl. 2, fig. II, 7.*

This species was rare in the two localities. In both cases it occurred in running water.

Monroe County: Davy's Run, 2013 *Patrick* (A-2107), 2019 *Patrick* (A-2119). Pike County: 1621 *Shulze* (A-2227).

Neidium affine v. **amphirhynchus** (Ehr.) Cl., 1894, K. Sv. Vet. Akad. Handl. **26** (2): 68.
Navicula amphirhynchus Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 417. *pl. 3, fig. I, 10.*

This variety was rare in two habitats.

Monroe County: Davy's Run, 2014 *Patrick* (A-2110). Wayne County: Angels, 2021 *Burke and Patrick* (A-2123).

Neidium bisulcatum (Lagst.) Cl., 1894, K. Sv. Vet. Akad. Handl. **26** (2): 68.
Navicula bisulcata Lagst., 1873, Bihang K. Sv. Vet. Akad. Handl. **1** (14): 31. *pl. 1, fig. 8.*

This species was rare in the two localities where it was collected.

Pike County: 127 *Shulze* (A-2215), 2188 *Shulze* (A-2234).

Neidium bisulcatum v. **undulatum** O. Müll., 1898, Forschungsber. Biol. Stat. Plön **6:** 62–63.

This variety was rare in occurrence.

Pike County: Greeley, 2 *Burke* (A-2188).

Neidium iridis (Ehr.) Cl., 1894, K. Sv. Vet. Akad. Handl. **26** (2): 69.
Navicula iridis Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 418. *pl. 4, figs. 1, 2.*

Though found in several localities, it was of frequent occurrence in none.

Luzerne County: Harvey Lake, 2042 *Hodge* (A-2160). Monroe County:

Davy's Run, 2014 *Patrick* (A-2109), 2019 *Patrick* (A-2119); Raymondskill Falls, 2025 *Patrick* (A-2131); Wier Lake, 2046 *Hodge* (A-2169). Northampton County: Green Pond, 2050 *Hodge* (A-2177). Pike County: 2188-90 *Shulze* (A-2234–36), 128–29 *Shulze* (A-2217–19); Greeley, 1 *Burke* (A-2184); Shohola Falls, 4 *Burke* (A-2192), 12 *Burke* (A-2204).

Neidium iridis v. **amphigomphus** (Ehr.) Mayer, 1917, Denks. K. Bayer. Bot. Ges. **13:** n. s. **7:** 30.

Navicula amphigomphus Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 417. *pl. 3, fig. I, 8.*

This variety was frequent in a locality simply designated by Shulze as Pike County.

Monroe County: Jaggie's Bog, 262 *Shulze* (A-2223). Pike County: 130 *Shulze* (A-2221).

Neidium iridis v. **ampliatum** (Ehr.) Cl., 1894, K. Sv. Vet. Akad. Handl. **26** (2): 69.

Navicula ampliata Ehr., 1842, Ber. K. Akad. Wiss. Berlin, **1842:** 337.

These specimens differ from the typical forms of this variety in that the sides of the valve are parallel and not convex.

Pike County: 2190 *Shulze* (A-2236).

Neidium iridis v. **vernale** Reichelt, 1897, Sitzungsber. Naturforsch. Ges. Leipsig **24:** 8–9.

This variety was only found once and then it was rare.

Pike County: 128 *Shulze* (A-2217).

DIPLONEIS EHRENBERG

This genus was rarely encountered in this study. The two species listed below were only found twice and then they were rare.

Diploneis ovalis (Hilse) Cl., 1891, Acta Soc. pro Fauna et Flora Fennica **8** (2): 44. *pl. 2, fig. 13.*

Pinnularia ovalis Hilse *in* Rabenhorst, 1861, Algen Europa, no. 1025.

Luzerne County: Harvey Lake, 2042 *Hodge* (A-2160). Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131).

Diploneis Smithii (Bréb. *ex* W. Sm.) Cl., 1894, K. Sv. Vet. Akad. Handl. **26** (2): 96.

Navicula Smithii Bréb. *ex* W. Sm., 1856, Brit. Diat. **2:** 92.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131).

STAURONEIS EHRENBERG

A. Ends of valve with septum, valves slightly biconstricted ..... **S. Smithii**

A. Ends of valve without septum

B. Raphe broad, striae usually less than 20 in 10 μ ..... **S. phoenicenteron**

B. Raphe linear, striae 20 or more in 10 μ ..... **S. anceps** and vars.

B. Raphe linear, striae about 30 in 10 μ, small forms usually less than 25 μ long **S. Kriegeri**

Stauroneis anceps Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 306, 422. *pl. 2, fig. I, 18.*

This species was found in several localities but was frequent in none.

Lackawanna County: Indian Lake, 2044 *Hodge* (A-2165). Monroe County: Davy's Run, 2014–15 *Patrick* (A-2110–11), 2018–19 *Patrick* (A-2118–19); Mountain Lake, 2048 *Hodge* (A-2172); Pocono Lake Preserve, South Pocono Lake, 2010 *Patrick* (A-2102); Trout Lake, 2049 *Hodge* (A-2174); Wier Lake, 2046–47 *Hodge* (A-2169–70). Pike County: 2188 *Shulze* (A-2234), 128–30 *Shulze* (A-2217–21); Shohola Falls, 12 *Burke* (A-2204).

Stauroneis anceps v. **amphicephala** (Kütz.) Cl., 1894, K. Sv. Vet. Akad. Handl. **26** (2): 148.

Stauroneis amphicephala Kütz., 1844, Bacill. p. 105. *pl. 30, fig. 25.*

This variety is characterized by having the striae easily resolved into punctae. It was only found in one locality and then it was rare.

Pike County: 127 *Shulze* (A-2215).

Stauroneis anceps v. **gracilis** (Ehr.) Brun, 1880, Diat. Alpes et Jura et Région Suisse et Française des Environs de Genève, p. 89. *pl. 9, fig. 2.*

Stauroneis gracilis Ehr., 1843, Abhandl. K. Wiss. Berlin **1841:** 423. *pl. 1, fig. II, 14.*

This variety though found in several localities was frequent in none.

Monroe County: Davy's Run, 2015 *Patrick* (A-2111); Pocono Lake Preserve, Mud Run, 2031 *Hodge* (A-2138); Pocono Lake, 2036 *Patrick* (A-2148). Wayne County: Angels, 2022 *Burke and Patrick* (A-2125).

Stauroneis anceps v. **linearis** (Ehr.) Van Heurck, 1880, Syn. Diat. Belgique, p. 69. *pl. 4, figs. 7, 8.*

Stauroneis linearis Ehr., 1843, Abhandl. K. Wiss. Berlin **1841:** 423. *pl. 1, fig. II, 11.*

This variety was found only in one locality and then it was rare.

Monroe County: Pocono Lake Preserve, Pocono Lake, 2036 *Patrick* (A-2148).

Stauroneis Kriegeri nomen nova

Valvae lineares 21 μ longae, 4 μ latae, apicibus constrictis capito-rostratis; striis radiantibus, 26 in 10 μ, area axiali angusta; stauro lineari.

This species was first observed by Krieger, who named it *Stauroneis pygmaea* (Beiträge zur Naturdenkmalpflege **13:** 272. *pl. 2, fig. 28* (1929)). However, this name is preoccupied by a species described by Castracana in 1886 (Voyage of H.M.S. Challenger, Botany **2:** 25. *pl. 29, fig. 7*).

As Krieger points out, this species may vary between 20–23 μ in length and 4–5 μ in breadth. He states the striae are 30 in 10 μ, but in my specimens they are 26 in 10 μ. The stauros may appear broader on one side of the central nodule than on the other.

This species is named in honor of Mr. Krieger.

Monroe County: Davy's Run, 2017 *Patrick* (A-2115). Wayne County: Angels, 2023 *Burke and Patrick* (A-2127).

Stauroneis phoenicenteron (Nitzsch.) Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** *pl. 2, fig. V, 1.*

Bacillaria phoenicenteron Nitzsch. 1817, N. Schrift. Naturf. Ges. Halle **3:** 92.

This species was common in the squeezings from surface vegetation in shallow water of Wier Lake where the pH of the water was 6.6. It is also common in some collections by Shulze from Pike County.

Luzerne County: Harvey Lake, 2042 *Hodge* (A-2160). Monroe County: Jaggie's Bog, 262–63 *Shulze* (A-2223–25); Pocono Lake Preserve, South Pocono Lake, 2010 *Patrick* (A-2101); Raymondskill Falls, 2025 *Patrick* (A-2131); Wier Lake, 2046 *Hodge* (A-2168). Northampton County: Green Pond, 2050 *Hodge* (A-2176). Pike County: 127–29 *Shulze* (A-2215–19), 2190 *Shulze* (A-2236); Bushkill Creek, 1621 *Shulze* (A-2227). Wayne County: Angels, 2021 *Burke and Patrick* (A-2124).

Stauroneis Smithii Grun., 1860, Verh. Zool. Bot. Ges. Wien **10:** 464. *pl. 4* (Grunow's *pl. 6*), *fig. 16.*

This species, occurring only in flowing water, was rare in the localities given below.

Monroe County: Davy's Run, 2018 *Patrick* (A-2117); Pike County: Shohola Falls, 3–4 *Burke* (A-2190–92), 11 *Burke* (A-2202).

NAVICULA

A. Punctae of striae forming longitudinal and transverse rows perpendicular to each other ..... **Naviculae Orthostichae**

A. Punctae of striae forming decussating rows ..... **Naviculae Decussatae**

A. Punctae of striae not as above

B. Striae transversely lineate ..... **Naviculae Lineolatae**

B. Striae not transversely lineate

C. Raphe enclosed in silicious rib, terminal nodule thickened **Naviculae Bacillares**

C. Raphe not enclosed

D. Central pores somewhat distant, axial area narrow or uniting with central area to form a lanceolate space **Naviculae Entoleiae**

D. Central pores not distant

E. Central area not distinct — small forms less than 20 μ **Naviculae Minusculae**

E. Central area variously formed

F. Striae radiate throughout

G. Striae clearly alternately long and short at central area, valves more or less elliptic in shape ..... **Naviculae Heterostichae**

G. Striae may be uneven but not definitely longer and shorter at central area — central area quadrate or forming a transverse fascia **Naviculae Mesoleiae**

F. Striae not radiate throughout, median striae distinctly more distant from each other than those in other parts of the valve **Naviculae Decipientes**

NAVICULAE ORTHOSTICHAE Cleve

Valves usually elongate, lanceolate to linear. The median line with small or elongate central nodule, and with small or indistinct terminal fissures.

Navicula cuspidata Kütz., 1844, Bacill., p. 94. *pl. 3, fig. 24.*
Frustulia cuspidata Kütz., 1833, Linnaea **8**: 549. *pl. 14, fig. 26.*

This species was present only in one locality.
Luzerne County: Harvey Lake, 2042 *Hodge* (A-2161).

NAVICULAE DECUSSATAE Cleve

Valves elliptical with attenuate rostrate ends. The punctae of the striae are arranged in obliquely decussating rows. There is only one species in this region.

Navicula placenta Ehr., 1854, Mikrogeologie, p. 33. *pl. 12, fig. 23.*

This species, though found in several habitats, was very frequent in only one, where it occurred on a wall dripping with water to the side of Shohola Falls.

Pike County: 2188–89 *Shulze* (A-2234–35); Bushkill Creek, 1623 *Shulze* (A-2231); Greeley, 1 *Burke* (A-2184), 2 *Burke* (A-2188); Shohola Falls, 14 *Burke* (A-2208–10). Wayne County: Angels, 2021 *Burke and Patrick* (A-2123).

NAVICULAE LINEOLATAE Cleve

A. Terminal striae parallel or convergent
  B. Striae usually 15 or more in 10 μ; valves usually less than 50 μ long
    C. Linear or slightly lanceolate with rounded ends, the median stria on each side of the central nodule often decidedly longer than the other striae about the central nodule ..... **N. cincta** and var.
    C. Central area more or less rounded
      D. Valve rhombic lanceolate ..... **N. cryptocephala v. pumila**
      D. Valve lanceolate with attenuate, rostrate ends **N. cryptocephala**
      D. Valve lanceolate with acute ends **N. radiosa v. tenella**
  B. Striae less than 15 in 10 μ
    E. Valves 30 μ or less in length
      F. Valves with strongly capitate ends, striae 8–10 in 10 μ **N. hungarica v. capitata**
      F. Valves with slightly rostrate ends, striae 14 in 10 μ **N. cryptocephala v. veneta**
    E. Valves longer than 30 μ
      G. Terminal nodule of valve expanded to produce a hyaline space **N. globulifera**
      G. Terminal nodule not so expanded

H. Ends of valve variously produced
I. Ends of valve attenuate-rostrate and slightly capitate; valve lanceolate
N. rhynchocephala
I. Ends of valve cuneate; valve linear
N. viridula v. linearis
H. Ends of valve not produced; valve lanceolate
N. radiosa

A. Terminal striae radiate throughout
J. Striae at central area equally shortened
K. Central area more or less rounded
L. Valve lanceolate, striae at central area more distantly spaced
N. lanceolata
L. Valve ovate lanceolate with attenuate, rostrate ends
N. anglica
K. Central area transverse, central striae not more distantly spaced
N. dicephala
J. Striae at central area irregular in length
M. Striae at central area alternately longer and shorter and distinctly more distantly spaced than in the rest of the valve
N. quadripartita
M. Striae not distinctly more distantly spaced about the central area
N. Striae 16–18 in 10 μ; valve elliptical-lanceolate with distinctly attenuate rostrate ends .....**N. decussis**
N. Striae coarser; valve ovate-lanceolate, ends distinctly attenuate rostrate .....**N. exigua v. capitata** n. var.

Navicula anglica Ralfs *apud* Pritchard, 1861, Syst. Hist. of the Infusoria, p. 900.

This species was rare in two collections.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: 127 *Shulze* (A-2215).

Navicula cincta (Ehr.) Ralfs *apud* Pritchard, 1861, Syst. Hist. of the Infusoria, p. 901.
Pinnularia cincta Ehrenberg, 1854, Mikrogeologie, *pl. 10, fig. II, 6.*

For further discussion concerning the authorities for this name see Proc. Acad. Nat. Sci. Phila. **95:** 72.

This species was found only in one habitat and then it was rare.

Monroe County: Popomoning Lake, 2045 *Hodge* (A-2166).

Navicula cincta v. angusta (Grun.) Cl., 1893, K. Sv. Vet. Akad. Handl. **27** (3): 17.
Navicula angusta Grun., 1860, Verh. Bot. Zool. Ges. Wien **10:** 528. *pl. 3, fig. 19.*

This variety was rare in both localities. The specimens in Tobyhanna Creek were shorter than usual, being only 40 μ long.

Monroe County: Pocono Lake Preserve, Tobyhanna Creek, 2033 *Patrick* (A-2142). Pike County: Shohola Falls, 14 *Burke* (A-2210).

Navicula cryptocephala Kütz., 1844, Bacill., p. 95. *pl. 3, fig. 26.*

Monroe County: Trout Lake, 2049 *Hodge* (A-2175); Wier Lake, 2047 *Hodge* (A-2170); Raymondskill Falls, 2025 *Patrick* (A-2131). Northamp-

ton County: Green Pond, 2050 *Hodge* (A-2176). Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195); Shohola Falls, 3 *Burke* (A-2190), 4 *Burke* (A-2192). Wayne County: Angels, 2022 *Burke and Patrick* (A-2125), 2026 *Burke and Patrick* (A-2134).

Navicula cryptocephala v. **pumila** Grun. *apud* Van Heurck, 1880, Syn. Diat. Belgique, *pl. 8, fig. 6, 7.*

Grunow suggests this is a variety but questions it. However, later writers such as Cleve and Hustedt have given him credit for this combination.

Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2095). Wayne County: Angels, 2026 *Burke and Patrick* (A-2134).

Navicula cryptocephala v. **veneta** (Kütz.) Rabh., 1864, Flora Europaea Algarum, p. 198.

Navicula veneta Kütz., 1844, Bacill., p. 95. *pl. 30, fig. 76.*

This variety was rare in the one locality.

Northampton County: Green Pond, 2050 *Hodge* (A-2176).

Navicula dicephala Ehr., 1838, Die Infusionsthierchen als volkommene Organismen, p. 185.

This species was rare in the various localities in which it was encountered.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: 2188 *Shulze* (A-2234); Bushkill Creek, 1623 *Shulze* (A-2231); Shohola Falls, 12 *Burke* (A-2205).

Navicula decussis Oestrup, 1910, Danske Diat., p. 77. *pl. 2, fig. 50.*

My specimens are as Oestrup's illustration except that the striae appear to be somewhat curved. Hustedt in A. Schmidt's Atlas Diatomaceen-Kunde, *pl. 398, figs. 36, 37,* illustrates a diatom with curved striae and a punctum in the central nodule which he assigns to this species.

I cannot be sure, from the descriptions and original illustrations, of the difference between *N. decussis* and *N. Thingvallae.* I have not seen the types so will not try to make any critical evaluation of the two species.

This species was not of frequent occurrence in any of the habitats.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195). Wayne County: Angels, 2021 *Burke and Patrick* (A-2123–24).

Navicula exigua v. **capitata** var. nov.

Valvae elliptico-lanceolatae, apicibus rostrato-capitatis, 29 μ longae, 10 μ latae; striis 14–15 in 10 μ, radiantibus, ad nodulum centralem longis inaequaliter; area axiali angusta; area centrali transversa. **Type:** Shohola Falls, 10 *Burke* (A-2200).

The specimens vary in length from 22–30 μ, in breadth from 10–11 μ. Hustedt has illustrated in A. Schmidt's Atlas der Diatomaceen-Kunde, *pl. 398, figs. 24–26,* specimens which seem to be the same as mine. He has placed them under the species name. However, if one examines the original figure and description of Gregory, it is clear that Hustedt's specimens are not the same as the type. Gregory (Quart. Jour. Micros. Sci. **2:** 98–99.

pl. 4, fig. 14) states, "its form is broadly elliptical with acute but not produced apices — the striae are distinct and radiate."

Grunow in Van Heurck's Synopsis des Diatomées Belgique (*pl. 8, fig. 32*) and in Cleve and Moeller Type Slide no. 261 indicates that this species has a transverse central area formed by the irregular shortening of the central striae. Otherwise his specimens are as Gregory's illustration. The question as to whether Grunow's and Gregory's specimens are the same will have to await the study of type or isotype material since Gregory makes no statement concerning the central area.

Pike County: 2188 *Shulze* (A-2234); Lake Wallenpaupek tributary, 5 *Burke* (A-2195); Shohola Falls, 10–11 *Burke* (A-2200–02), 14 *Burke* (A-2210).

Navicula globulifera Hustedt, 1927, Archiv für Hydrobiol. **18:** 164. *pl. 5, fig. 7.*

I believe this is the first record of this species in North America. My specimens are 37–39 μ long, 5.8–7 μ broad, and the striae are 12 in 10 μ.

Monroe County: Trout Lake, 2049 *Hodge* (A-2175). Pike County: Greeley, 2 *Burke* (A-2188); Lake Wallenpaupek tributary, 5 *Burke* (A-2195). Wayne County: Angels, 2021 *Burke and Patrick* (A-2123).

Navicula hungarica v. **capitata** (Ehr.) Cl., 1895, K. Sv. Vet. Akad. Handl. **27** (3): 16.
Pinnularia capitata Ehr., 1854, Mikrogeologie, *pl. 37, fig. III, 9.*

In 1848, Ehrenberg (Ber. K. Akad. Wiss. Berlin **1848:** 18) just mentions this species. In 1838 Ehrenberg (Infusionsthierchen als volkommene Organismen, p. 185, *pl. 13, fig. 20*) describes a *Navicula capitata* which is quite different from the species in question.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: Shohola Falls, 4 *Burke* (A-2192).

Navicula lanceolata (Ag.) Kütz., 1844, Bacill., p. 94. *pl. 30, fig. 48*; *pl. 28, fig. 38.*
Frustulia lanceolata Ag., 1827, Flora (Bot. Zeitung) **10:** 626.

Northampton County: Green Pond, 2050 *Hodge* (A-2177).

Navicula quadripartita Hustedt, 1937, Archiv für Hydrobiol. und Planktonk. Suppl. **15:** 263.

This species is first published by Hustedt in 1934 in A. Schmidt's Atlas Diatomaceen-Kunde, *pl. 400, figs. 12–15.* According to the International Rules of Botanical Nomenclature this is not a valid publication so the above later record is given.

Hustedt states that this species is usually associated with moss.

Pike County: Bushkill Creek, 1623 *Shulze* (A-2231); Greeley, 2 *Burke* (A-2188); Lake Wallenpaupek tributary, 5 *Burke* (A-2195).

Navicula radiosa Kütz., 1844, Bacill., p. 91. *pl. 4, fig. 23.*

This species was very frequent from the squeezings of the surface vegetation of Mountain Lake.

Luzerne County: Harvey Lake, 2042–43 *Hodge* (A-2160–62). Monroe

County: Mountain Lake, 2051 *Hodge* (A-2178); Popomoning Lake, 2045 *Hodge* (A-2166). Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195); Shohola Falls, 10–11 *Burke* (A-2200–02).

Navicula radiosa v. **tenella** (Bréb.) Cl., 1895, K. Sv. Vet. Akad. Handl. **27** (3): 17.
Navicula tenella Bréb. *ex* Kütz., 1849, Spec. Algarum, p. 74.

This species was of very frequent occurrence in certain habitats of Pocono Lake, Trout Lake, and Shohola Falls. It seems to prefer shallow water and is associated with algae or moss.

Luzerne County: Harvey Lake, 2042–43 *Hodge* (A-2160–62). Monroe County: Davy's Run, 2015 *Patrick* (A-2111), 2019 *Patrick* (A-2119); Mountain Lake, 2051 *Hodge* (A-2178); Pocono Lake Preserve, Pocono Lake, 2035–36 *Patrick* (A-2146–48), 2065 *Patrick* (A-2182); Tobyhanna Creek, 2032–33 *Patrick* (A-2140–42); South Pocono Lake, 2010 *Patrick* (A-2101); Trout Lake, 2049 *Hodge* (A-2174). Pike County: Greeley, 1 *Burke* (A-2184); Shohola Falls, 3–4 *Burke* (A-2190–92), 10–11 *Burke* (A-2200–02), 13 *Burke* (A-2206). Wayne County: Angels, 2021 *Burke and Patrick* (A-2123).

Navicula rhynchocephala Kütz., 1844, Bacill., *pl. 30, fig. 35.*

This species, though found in several localities was rare in all.

Luzerne County: Harvey Lake, 2042–43 *Hodge* (A-2160–62). Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195); Shohola Falls, 10 *Burke* (A-2201). Wayne County: Angels, 2026 *Burke and Patrick* (A-2134).

Navicula viridula v. **linearis** Hustedt

This variety was first published in 1936 in A. Schmidt's Atlas Diatomaceen-Kunde *pl. 405, figs. 13, 14.* No description was present. Later, 1937, Archiv für Hydrobiologie, Supplement **15:** 264 a description in German was given. To date no Latin description has been furnished so I am including one in order to validate the name.

Valvae lineares, 65–100 μ longae, 12 μ latae, apicibus cuneatis; striis 8–9 in 10 μ, intermediis radiantibus, terminalibus convergentibus, distincte transverse lineatis.

This species though rare in several localities was frequent in none.

Luzerne County: Harvey Lake, 2042 *Hodge* (A-2160). Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: Shohola Falls, 10 *Burke* (A-2201). Wayne County: Angels, 2021 *Burke and Patrick* (A-2123), 2026 *Burke and Patrick* (A-2134).

NAVICULAE BACILLARES Cleve

Navicula americana Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 417.

At Shohola Falls a form only 38 μ long and 7 μ broad was found. In no case was this diatom of frequent occurrence.

Pike County: 127 *Shulze* (A-2215), 130 *Shulze* (A-2221); Shohola Falls, 10 *Burke* (A-2201).

Navicula bacillum Ehr., 1839, Abhandl. K. Akad. Wiss. Berlin **1838:** 130.

This species was found in only two localities and was frequent in neither. Luzerne County: Harvey Lake, 2043 *Hodge* (A-2162). Wayne County: Angels, 2021 *Burke and Patrick* (A-2123).

NAVICULAE ENTOLEIAE Cleve

A. Frustules in filaments
  B. Valves lanceolate, striae marginal ..... **N. Keeleyi**
  B. Valve concave, striae not marginal..... **N. contenta v. biceps**
A. Frustules not in filaments.
  C. Valves concave, length of valve 20 μ or more, ends narrowed, rostrate **N. concava**
  C. Valves not concave
    D. Striae more than 20 in 10 μ
      E. Valves swollen at center, about 15 μ long . **N. perpusilla**
      E. Valves linear-lanceolate, not swollen at center of valve over 20 μ long ..... **N. poconoensis**
    D. Striae less than 20 in 10 μ, ends of valve distinctly capitate **N. hassiaca**

Navicula concava sp. nov.

PLATE II, FIG. 6

Valvae utrimque concavae, 21.7 μ longae, 5 μ ad nodulum centralem latae; apicibus rostratis, area axiali late lanceolata; area centrali inaequali; striis 27–28 in 10 μ, prope medium radiantibus in apicibus parallelis. **Type:** Pike County; Greeley, squeezings from *Sphagnum* in swamp, 2 *Burke* (A-2188).

This diatom is typical of the members of the Entoleiae except the striae are parallel or only very slightly radiate at the ends. Cleve in describing the group states that the striae are radiate at the ends. However, as the species fits this group in all other respects, I think it well to include it until a more thorough study is made.

This species occurred in only one locality, but was of frequent occurrence. Pike County: Greeley, 2 *Burke* (A-2188–89).

Navicula contenta v. **biceps** (Arnott) Van Heurck, 1885, Syn. Diat. Belgique, p. 109. *Diadesmis biceps* Arn. *ex* Cl. and Möll. no. 175. The determinations of these specimens were made by Grunow.

This variety is rare in the two localities.

Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195); Shohola Falls, 9 *Burke* (A-2198), 14 *Burke* (A-2208).

Navicula hassiaca Krasske, 1925, Abhandl. u. Ber. Ver. für Naturk. **56:** 47. *pl. 2, fig. 26.*

Pike County: Greeley, 1 *Burke* (A-2184); Lake Wallenpaupek tributary, 14 *Burke* (A-2210).

Navicula Keeleyi sp. nov.

PLATE II, FIG. 7

Valvae lanceolatae 19–30 μ longae, 4–5 μ latae, in fibris; apicibus capitato-rostratis, area axiali et area centrali late lanceolata; striis marginibus, 30 in 10 μ. **Type:** Pike County, Shohola Falls, scrapings from dripping rock face, side wall of gorge, above concrete bridge crossing road below falls, 7 *Burke* (A-2197).

This species is named in honor of Mr. Frank J. Keeley who first called my attention to this diatom. He found it in wet moss at Flat Rock, Montgomery County, Pennsylvania. Mr. Keeley has also helped me in describing the species.

This species is very common in these collections. Its manner of growth in filaments immediately calls it to one's attention. It is distinguished from the other filamentous forms of this group by its broad axial and central areas which form a lanceolate space.

Pike County: Shohola Falls, 7 *Burke* (A-2196–97), 9 *Burke* (A-2198–99).

Navicula perpusilla Grun., 1860, Verh. Zool. Bot. Ges. Wien **10:** 552. *pl. 4* (Grunow *pl. 2*), *fig. 7.*

Hustedt states that this species is found especially in mountainous regions. This species was very frequent on a dripping rock face at Shohola Falls.

Pike County: Shohola Falls, 7 *Burke* (A-2196), 9 *Burke* (A-2198).

Navicula poconoensis sp. nov.

PLATE II, FIG. 5

Valvae linearis-lanceolatae 26.4 μ longae, 4.6 μ latae, apicibus late rostratis; area axiali lanceolata, area centrali rotundata; striis 31 in 10 μ, in apicibus parallelis. **Type:** Pike County, Greeley, squeezings from *Sphagnum* in swamp, 2 *Burke* (A-2188).

This species, as *N. concava*, differs from other members of the Entoleiae in that the terminal striae are parallel instead of radiate, but it agrees in all other respects with members of this group.

The species is most closely related to *N. Flotowii* but differs from it in the size of the valve, the shape of the apices, and the fact that it does not form filaments.

Pike County: Greeley, 2 *Burke* (A-2188–89).

NAVICULAE MINUSCULAE Cleve

A. Valve elliptical in outline, striae about 30 in 10 μ
   B. Striae parallel or slightly radiate ..... **N. muralis**
   B. Striae strongly radiate ..... **N. atomus**
A. Valve linear-elliptic with rostrate ends, striae about 30 in 10 μ. As seen through the microscope the striae at margin of valve are on a different level of focus than at raphe ..... **N. festiva**

Navicula atomus (Kütz.) Grun., 1860, Verh. Zool. Bot. Ges. Wien **10:** 552. *pl. 2, fig. 6. Amphora atomus* Kütz., 1844, Bacill., p. 108. *pl. 30, fig. 70.*

This species was only found in one locality.
Pike County: Shohola Falls, 11 *Burke* (A-2202).

Navicula festiva Krasske, 1925, Abhandl. u. Bericht. Ver. für Naturk. Cassel **56:** 47. *pl. 1, fig. 16.*

The name *Navicula vitrea* (Oestrup) Hustedt cannot be applied to this species as it is preoccupied by *N. vitrea* Cleve, 1893, (K. Sv. Vet. Akad. Handl. **26** (*2*): 111).
This species was of very frequent occurrence at Greeley, where it was found in association with *Sphagnum.*
Pike County: Greeley, 2 *Burke* (A-2188).

Navicula muralis Grun. *apud* Van Heurck, 1880, Syn. Diat. Belgique, *pl. 14, fig. 27.*

This species was rare in the one locality.
Monroe County: Trout Lake, 2049 *Hodge* (A-2174).

NAVICULAE HETEROSTICHAE Cleve

A. Valve elliptical in shape, central area large and rounded....**N. scutiformis**
A. Valve lanceolate to rhombic-elliptical, central area indistinct . **N. cocconeiformis**
A. Valve orbicular, central area indistinct, less than 20 μ long. .**N. pseudoscutiformis**

Navicula cocconeiformis Greg., 1856, Quart. Jour. Micros. Sci. **4:** 6. *pl. 1, fig. 22.*

This species was only found in running water, but it was not of frequent occurrence in any habitat wherein it was found.
Monroe County: Davy's Run, 2014 *Patrick* (A-2110), 2016–18 *Patrick* (A-2113–18), 2056 *Patrick* (A-2180); Pocono Lake Preserve, Tobyhanna Creek, 2033 *Patrick* (A-2142). Pike County: Shohola Falls, 10–11 *Burke* (A-2201–02), 13 *Burke* (A-2206).

Navicula pseudoscutiformis Hustedt *apud* Pascher, 1930, Die Süssw. Flora Mitteleurop., Heft 10: 291. *fig. 495.*

This species was rare in the localities where it was found.
Monroe County: Davy's Run, 2019 *Patrick* (A-2119); Wier Lake, 2047 *Hodge* (A-2170). Pike County: Shohola Falls, 11 *Burke* (A-2202), 14 *Burke* (A-2210).

Navicula scutiformis Grun., 1881, in A. Schmidt's Atlas Diat., *pl. 70, fig. 62.*

This species was found in only one locality.
Monroe County: Davy's Run, 2019 *Patrick* (A-2119).

NAVICULAE MESOLEIAE Cleve

The valve is symmetrical, linear to elliptical with usually obtuse or rostrate ends. The axial area is narrow or indistinct. The central area is

large, quadrate or a transverse fascia. The striae are fine, punctate and radiate throughout. The connecting zone is not complex.

A. Valves with isolated stigma in the central area; valve often somewhat lanceolate in shape and may have rostrate capitate ends.....**N. mutica**
A. Valves without an isolated stigma in the central area, ends of valve broadly rounded.
  B. Terminal nodules laterally expanded to form a clear area . **N. pupula** and vars.
  B. Terminal nodules not so expanded
    C. Terminal striae radiate and curved.....**N. bacilliformis**
    C. Terminal striae not so formed
      D. Median striae at the central area approximately the same length so that the central area appears clear-cut but small **N. minima** var.
      D. Median striae of central area very irregular in length
        E. Very small forms, almost orbicular in shape **N. subatomoides**
        E. Valves over 12 μ long, elliptical in shape
          F. Central area broad, somewhat rhomboidal in shape **N. variostriata**
          F. Central area narrowly rectangular in shape **N. Rotaeana**

Navicula bacilliformis Grun., 1880, K. Sv. Vet. Akad. Handl. **17** (2): 44. *pl. 2, fig. 51.*

This species was rare in the two localities cited below.

Monroe County: Popomoning Lake, 2045 *Hodge* (A-2166); Wier Lake, 2047 *Hodge* (A-2170).

Navicula minima v. **atomoides** (Grun.) Cl., 1894, K. Sv. Vet. Akad. Handl. **26** (2): 128.

Navicula atomoides Grun. *apud* Van Heurck, 1880, Syn. Diat. Belgique *pl. 14, fig. 12*, text (1885) p. 107. Van Heurck Type Slide no. 219.

This species was very frequent in the bottom vegetation in shallow water in Wier Lake and Davy's Run and in scrapings from rocks at Shohola Falls.

Monroe County: Davy's Run, 2016–17 *Patrick* (A-2113–15); Pocono Lake Preserve, Tobyhanna Creek, 2032 *Patrick* (A-2140); Pocono Lake, 2037 *Patrick* (A-2150); Wier Lake, 2047 *Hodge* (A-2171). Pike County: Shohola Falls, 14 *Burke* (A-2208).

Navicula mutica Kütz., 1844, Bacill., p. 93. *pl. 3, fig. 32.*

This species was rare.

Pike County: Shohola Falls, 10 *Burke* (A-2200).

Navicula pupula Kütz., 1844, Bacill., p. 93. *pl. 30, fig. 40.*

Though found in several localities this species was only frequent in the squeezings from moss collected in the spillway of Mud Run.

Monroe County: Davy's Run, 2014 *Patrick* (A-2109), 2019 *Patrick* (A-2119); Raymondskill Falls, 2025 *Patrick* (A-2131); Pocono Lake Preserve, Mud Run, 2031 *Hodge* (A-2138); Pocono Lake, 2036 *Patrick* (A-2149). Northampton County: Green Pond, 2050 *Hodge* (A-2176). Pike County: 127 *Shulze* (A-2215).

Navicula pupula v. **bacillaroides** Grun. *apud* Cl. and Grun., 1880, K. Sv. Vet. Akad. Handl. **17** (2): 45.

I do not believe as Hustedt does that this variety and var. *rectangularis* of Grunow should be united. I have seen Cleve and Moeller's Type Slide No. 86 which has on it var. *rectangularis*. These specimens are quite distinct from those of var. *bacillaroides*. The sides of the valve are linear or somewhat concave while those of var. *bacillaroides* are somewhat convex. Also var. *bacillaroides* seems to have a more robust structure than var. *rectangularis*.

This variety was only encountered once in this study.

Northampton County: Green Pond, 2050 *Hodge* (A-2176).

Navicula pupula v. **capitata** Hustedt *apud* Pascher, 1930, Süssw. Flora Mitteleurop., Heft 10: 281. *fig. 467c.*

Though found in several localities this variety was always rare.

Monroe County: Pocono Lake Preserve, Pocono Lake, 2065 *Patrick* (A-2182); Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: Shohola Falls, 11–12 *Burke* (A-2202–05). Wayne County: Angels, 2021 *Burke and Patrick* (A-2123).

Navicula Rotaeana (Rabh.) Van Heurck, 1880, Syn. Diat. Belgique, *pl. 14, fig. 17.* *Stauroneis Rotaeana* Rabh., 1852, Hedwigia **1:** 103. *pl. 13, fig. 7.*

Though found in many habitats this species was common only in Davy's Run. Here it was often found associated with the mosses *Hypnum* and *Fontinalis*.

Luzerne County: Harvey Lake, 2042 *Hodge* (A-2160). Monroe County: Davy's Run, 2014–19 *Patrick* (A-2110–19); Pocono Lake Preserve, Tobyhanna Creek, 2032–33 *Patrick* (A-2140–42); Pocono Lake, 2035 *Patrick* (A-2147); Spring Run, 2037 *C. Myers* (A-2150); Trout Lake, 2049 *Hodge* (A-2174). Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195); Shohola Falls, 3–4 *Burke* (A-2190–92), 13 *Burke* (A-2206). Wayne County: Angels, 2021 *Burke and Patrick* (A-2123).

Navicula subatomoides Hustedt, 1936, *in* A. Schmidt's Atlas der Diatomaceen-Kunde, *pl. 404, figs. 33–35.*

As this species has not been validly described I am supplying the following description.

Valvae ellipticae 6–7 μ longae, 4–5 μ latae, area axiali anguste, area centrali lata stauroneiformi; striis 44 in 10 μ, radiantibus.

This species was very common in the squeezings from *Hypnum* and *Fontinalis* in Davy's Run.

Monroe County: Davy's Run, 2019 *Patrick* (A-2119). Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195).

Navicula variostriata Krasske, 1923, Bot. Archiv. **3:** 197. *fig. 12.*

This species was rare in the localities in which it was found. Hustedt

states that it is especially found associated with *Sphagnum*. This did not seem to be necessarily the case in the habitats in which it was found in this study.

Pike County: Bushkill Creek, 1623 *Shulze* (A-2231); Greeley, 2 *Burke* (A-2188); Shohola Falls, 14 *Burke* (A-2209–10).

NAVICULAE DECIPIENTES Cleve

Navicula halophila v. **minor** Kolbe, 1927, Pflanzenforschung **7:** 67. *pl. 1, fig. 4.*

Kolbe states that this variety is a "mesohalobien." If I am correct in believing that my specimens belong to this variety, then it should be noted that this variety also is found in somewhat acid, shallow, fresh water. I have not seen any authenticated specimens of var. *minor*, but a careful analysis of Kolbe's figure would indicate that my specimens are the same. My specimens are about 17 μ long, 6 μ broad, and the striae are 19 in 10 μ.

Monroe County: Pocono Lake Preserve, South Pocono Lake, 2010 *Patrick* (A-2101); Tobyhanna Creek, 2032 *Patrick* (A-2140). Pike County: Shohola Falls, 4 *Burke* (A-2192), 11 *Burke* (A-2202).

Navicula semen Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin, **1841:** 419. *pl. 1, fig. II, 17-a?; pl. 4, fig. II, 8.*

This species was very frequent in two localities or collections of Shulze which were simply indicated as Pike County.

Monroe County: Jaggie's Bog, 262–63 *Shulze* (A-2223–25). Pike County: 128–129 *Shulze* (A-2217–19).

PINNULARIA EHRENBERG

A. Striae distinctly separated from each other.....**Distantes**
A. Striae close to each other
  B. Striae short, perpendicular or almost so to the raphe
    C. Large forms, striae typically less than 15 in 10 μ....**Brevistriatae**
    C. Small forms, striae more than 15 in 10 μ.....**Parallelestriae**
  B. Striae not perpendicular to the raphe nor typically short
    C. Raphe linear
      D. Valves with capitate or rostrate ends which are narrower than the rest of the valve, usually small forms.....**Capitatae**
      D. Valves with ends not distinctly narrower than rest of valve
        E. Striae somewhat radiant in the middle and convergent at the ends, larger forms, usually over 40 μ long **Tabellariae**
        E. Striae strongly radiant in the middle and convergent at the ends, raphe at terminal nodules bayonet-shaped **Divergentes**
    C. Raphe broad
      F. Simple .....**Maiores**
      F. Twisted .....**Complexae**

DISTANTES Cleve subgenus

Pinnularia borealis Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 420. *pl. 1, fig. II, 6; pl. 4, fig. I, 5; pl. 4, fig. V, 4.*

This species was frequent on dripping rocks at Shohola Falls. Pike County: 128 *Shulze* (A-2217); Shohola Falls, 9 *Burke* (A-2198).

BREVISTRIATAE subgenus

A. Valve triundulate, ends rostrate-capitate, axial area granular **P. nodosa**

A. Valves not triundulate

B. Valves more or less swollen at center, ends capitate, axial area granular **P. acrosphaeria** and var.

B. Valve linear, ends rounded, axial area clear..... **P. brevicostata**

Pinnularia acrosphaeria W. Smith, 1853, Brit. Diat., **1:** 58. *pl. 19, fig. 183.*

This species, though found in several localities in Pike County, was never of frequent occurrence.

Pike County: 2190 *Shulze* (A-2236), 128–130 *Shulze* (A-2217–21); Bushkill Creek, 1621 *Shulze* (A-2227); Greeley, 2 *Shulze* (A-2188); Shohola Falls, 3 *Burke* (A-2190), 13 *Burke* (A-2206), 14 *Burke* (A-2210).

Pinnularia acrosphaeria var. **turgidula** Grun. *apud* Cleve, 1895, K. Sv. Vet. Akad. Handl. **27** (3): 86.

This very distinctive species was never of frequent occurrence.

Monroe County: Pocono Lake Preserve, Pocono Lake, 2035 *Patrick* (A-2146); Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: Shohola Falls, 3 *Burke* (A-2190).

Pinnularia brevicostata Cleve, 1891, Acta Soc. pro Fauna et Flora Fennica **8** (2): 25. *pl. 1, fig. 5.*

This species was only found once and then it was rare. It may have been a contamination.

Pike County: 2190 *Shulze* (A-2236).

Pinnularia nodosa (Ehr.) W. Smith, 1856, Brit. Diat., **2:** 96.

Navicula nodoso Ehr., 1838, Die Infusionsthierchen als volkommene Organismen, p. 179. *pl. 13, fig. 9.*

This species was of common occurrence in a locality given by Shulze only as Pike County.

Monroe County: Jaggie's Bog, 262 *Shulze* (A-2223). Pike County: 127–128 *Shulze* (A-2215–17); 2188 *Shulze* (A-2233); Bushkill Creek, 1621–23 *Shulze* (A-2227–31); Greeley, 1 *Burke* (A-2184); Shohola Falls, 12 *Burke* (A-2205).

PARALLELISTRIATAE Cleve subgenus

Pinnularia fasciata (Lagst.) Hustedt *apud* Pascher, 1930, Süssw. Flora Mitteleurop., Heft 10: 316. *fig. 569.*

Navicula fasciata Lagst., 1873, Bihang K. Sv. Vet. Akad. Handl. **1** (14): 34. *pl. 2, fig. 11.*

This species was rare in one locality.
Pike County: Shohola Falls, 14 *Burke* (A-2210).

Pinnularia sublinearis (Grun.) Cl., 1895, K. Sv. Vet. Akad. Handl. **27** (3): 74.
Navicula sublinearis Grun. *apud* Van Heurck, 1880, Syn. Diat. Belgique, *pl. 6, figs. 25, 26*, text (1885) p. 76.

This species was rare in the one locality given below.
Wayne County: Angels, 2017 *Burke and Patrick* (A-2115).

CAPITATAE Cleve subgenus

A. Margins of valve triundulate with central area forming a stauros
P. mesolepta v. stauroneiformis

A. Margins of valve not triundulate
B. Valves lanceolate, axial area broad
C. Valve 30 or more μ long, striae 11–12 in 10 μ
P. Braunii v. amphicephala
C. Valve 20 μ long, striae 17 in 10 μ **P. Burkei**
B. Valves linear, ends of valve distinctly capitate
D. Striae almost parallel, slightly radiate at middle and convergent at ends
E. Central area a broad fascia **P. Hilseana**
E. Central area only slightly broader than the axial area
P. subcapitata
D. Striae distinctly radiate at center of valve, convergent at ends, central area rhomboidal sometimes forming a stauros
P. interrupta
B. Valves linear, ends subcapitate
F. Striae gradually shortened to form a very broad fascia
P. subcapitata v. paucistriata
F. Striae usually abruptly shortened to form a transverse fascia
P. subcapitata v. stauroneiformis

Pinnularia Braunii v. **amphicephala** (Mayer) Hustedt *apud* Pascher, 1930, Süssw.-Flora Mitteleurop., Heft 10: 319. *fig. 578.*
Pinnularia amphicephala Mayer, 1917, Denks. K. Bayern Bot. Ges. in Regensburg **13:** n.s. **7:** 136. *pl. 2, figs. 15, 16.*

This species was only found in one locality and then it was rare.
Monroe County: Pocono Lake Preserve, Davy's Run, 2014 *Patrick* (A-2109).

Pinnularia Burkei sp. nov.

PLATE III, FIG. 1

Valvae lanceolatae apicibus rostrato-capitatis, 19 μ longae, 3 μ latae, striis 17 in 10 μ, radiantibus, apice versus convergentibus. **Type:** Pike County: Greeley, 2 Burke (A-2189).

I place this species in the Capitatae with some hesitation. It has the characteristics of the species typically included in this group except for the

axial area. Typically, this group has a narrow axial area. However, if we include *Pinnularia Brauni* v. *amphicephala* within it, I believe we are justified in including this species.

This species is named in honor of Mr. Joseph F. Burke of the New York Botanical Gardens who has given me many diatom collections from Pike County.

This species was only found in two localities.

Pike County: Greeley, 2 *Burke* (A-2188–89); Shohola Falls, 14 *Burke* (A-2210).

Pinnularia Hilseana Janisch *apud* Hilse, 1860, Jahres-Ber. Schles. Ges. Väterl. Cult. **36:** 82.

The identification of these specimens has been checked with Rabenhorst's Algen. Sachs. resp. Mitteleurop. No. 953. This species was found only in association with *Sphagnum*. Because it has this very distinctive habitat as well as definite taxonomic characters, I do not believe it wise to consider it a variety of *P. subcapitata*, but think it should be kept as a separate species.

This species was of very frequent occurrence in Lake Tamaque.

Monroe County: Pocono Lake Preserve, South Pocono Lake, 2011–12 *Patrick* (A-2103–05); shallow ditch on way to Davy's Run, 2013 *Patrick* (A-2108); Lake Tamaque, 2040 *Hodge* (A-2156).

Pinnularia interrupta W. Sm., 1853, Brit. Diat., **1:** 59. *pl. 19, fig. 184.*

Though found in several localities this species was rare.

Lackawanna County: Indian Lake, 2044 *Hodge* (A-2165). Monroe County: Pocono Lake Preserve, Davy's Run, 2014 *Patrick* (A-2110), 2019 *Patrick* (A-2119), South Pocono Lake, 2010 *Patrick* (A-2102); Wier Lake, 2046 *Hodge* (A-2169). Northampton County: Green Pond, 2050 *Hodge* (A-2176). Pike County: Greeley, 1–2 *Burke* (A-2184–88); Shohola Falls, 10 *Burke* (A-2201), 12 *Burke* (A-2204).

Pinnularia mesolepta v. **stauroneiformis** (Grun.) Cl., 1895, K. Sv. Vet. Akad. Handl. **27** (3): 76.

Navicula mesolepta v. *stauroneiformis* Grun., 1860, Verh. Zool. Bot. Ges. Wien **10:** 520. *pl. 4* (Grunow *pl. 2*) *fig. 22b.*

This variety was rare in one locality.

Pike County: 127 *Shulze* (A-2215).

Pinnularia subcapitata Greg., 1856, Quart. Jour. Micros. Sci., **4:** 9. *pl. 1, fig. 30.*

This species, as figured by Gregory, has distinctly capitate ends and an indistinct central nodule. Certainly it does not form a stauros. Some workers have confused this typical species with its variety *stauroneiformis*. They have called specimens with a stauros and subcapitate ends by the specific name. A study of Gregory's original plate will show that the diatom he was describing is distinctly different from the stauroid variety.

Monroe County: Lake Tamaque, 2039 *Hodge* (A-2154).

Pinnularia subcapitata v. **paucistriata** Grun. *apud* Van Heurck, 1880, Syn. Diat. Belgique, *pl. 6, fig. 23.*

This diatom was only found once, but then it was of frequent occurrence. Pike County: Shohola Falls, 3 *Burke* (A-2190).

Pinnularia subcapitata v. **stauroneiformis** Van Heurck, 1880, Syn. Diat. Belgique, *pl. 6, fig. 22.*

This variety was found in several habitats but was frequent in none. Monroe County: Pocono Lake Preserve, Davy's Run, 2056 *Patrick* (A-2180), Spring Run, 2037 *C. Myers* (A-2150). Pike County: Greeley, 1–2 *Burke* (A-2186–88). Wayne County: 2021 *Burke and Patrick* (A-2123), 2024 *Burke and Patrick* (A-2129).

TABELLARIAE Cleve subgenus

In many instances it is very difficult to distinguish this group from the Divergentes. As I have not studied these groups critically, I shall follow the classification of Cleve and Hustedt.

A. Valves with lunate markings on each side of the central nodule **P. stomatophora**

A. Valves without such markings

B. Valves linear, apices rounded, striae strongly radiate at center of valve, gradually shortened to form a stauros..... **P. substomatophora**

B. Valves linear or linear-lanceolate with somewhat rostrate-capitate ends **P. gibba** and var.

Pinnularia gibba Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** *pl. 1, fig. II, 8; pl. 3, fig. I, 4.*

PLATE III, FIG. 2–5

I have not been able to find the original reference to *Pinnularia gibba.* In the above cited article, Ehrenberg gives four illustrations of *P. gibba.* One illustration, *Pl. 1, fig. II, 3,* Ehrenberg questions as being this species. The other three illustrations seem to refer to two distinctly different diatoms. Two illustrations, *Pl. 1, fig. II, 8,* and *Pl. 3, fig. I, 4,* are more as the present concept of *P. gibba.* The third illustration, *Pl. 2, fig. I, 24,* is hard to identify as being any form recognized to-day. Ehrenberg also describes in the above reference, p. 423, *Pl. 1, fig. II, 3, Stauroptera gibba.* He states that this is in some ways like *P. gibba,* but is a doubtful form. I have included in my plates reproductions of Ehrenberg's figures. Ehrenberg states the magnification is 300 times.

As to my specimens, two diatoms were found which belong to the *P. gibba* series. One was like the specimens on H. L. Smith Spec. Typ. No. 275 which is probably the typical form. The specimens which I found were always in association with *Sphagnum.*

This species was very frequent in a composite collection made by Mr. Frank Myers from Pocono Lake.

Monroe County: Lost Lake, 2020 *Turner* (A-2121); Pocono Lake Pre-

serve, Pocono Lake, *F. Myers* (A-2213), South Pocono Lake, 2011 *Patrick* (A-2103).

Pinnularia gibba v. **rostrata** var. nov.

PLATE III, FIG. 6

Valvae lineares, 69 μ longae, 10 μ latae, apicibus rostratis; area axiali lata; striis 9 in 10 μ, intermediis parum radiantibus, terminalibus convergentibus. **Type:** Monroe County: Pocono Lake, *F. Myers* (A-2213).

Monroe County: Mountain Lake, 2051 *Hodge* (A-2178); Pocono Lake Preserve, Pocono Lake, 2034 *Patrick* (A-2144), *F. Myers* (A-2213); Wier Lake, 2046 *Hodge* (A-2169).

Pinnularia stomatophora (Grun.) Cleve, 1895, K. Sv. Vet. Akad. Handl. **27** (3): 83.
Navicula stomatophora Grun., 1876, in A. Schmidt's Atlas Diatomaceen-Kunde, *pl. 44, figs. 24, 26.*

Though found in several localities this species was rare in all.

Pike County: 128 *Shulze* (A-2217), 2190 *Shulze* (A-2236); Shohola Falls, 14 *Burke* (A-2208).

Pinnularia substomatophora Hustedt, 1935, Archiv für Hydrobiol. und Planktonk. Suppl. **14:** 160. *pl. 2, fig. 14.*

This species is present in several localities but frequent in none.

Monroe County: Pocono Lake Preserve, Pocono Lake, *F. Myers* (A-2213); Wier Lake, 2046–47 *Hodge* (A-2169–70). Pike County: Greeley, 2 *Burke* (A-2188); Shohola Falls, 4 *Burke* (A-2192), 13 *Burke* (A-2206).

DIVERGENTES Cleve subgenus

This group seems to be closely allied to the Tabellariae and in some cases it is very hard to decide in which group a species belongs. As I have not made a critical study of these groups, I have followed the classification of Cleve.

A. Central area with a horseshoe-shaped thickening on each side of the central nodule **P. divergens** and vars.

A. Central nodule without such thickenings

B. Edge of valve triundulate ..... **P. legumen**

B. Valve linear, narrowed toward the ends

C. Length less than 25 μ ..... **P. obscura**

C. Length over 40 μ ..... **P. Brebissonii**

Pinnularia Brebissonii (Kütz.) Rabenhorst, 1864, Flora Europea Algarum, p. 222.
Navicula Brebissonii Kütz., 1844, Bacill., p. 93. *pl. 3, fig. 49; pl. 30, fig. 39.*

Kützing says that this species is the same as *Frustulia bipunctata* Breb. Cons. Diat., p. 18 (sec. specim.). Miss Hilda F. Harris has verified this reference for me, and states that no description or illustration is given. Therefore even if it is the same as *Frustulia bipunctata*, the name *Pinnularia Brebissonii* is valid.

Monroe County: Pocono Lake Preserve, Pocono Lake, *F. Myers* (A-2213). Pike County: 128 *Shulze* (A-2217), 2188 *Shulze* (A-2234).

Pinnularia divergens W. Sm., 1853, Brit. Diat., **1:** 57. *pl. 18, fig. 177.*

This species though found in several localities is frequent in none.

Monroe County: Davy's Run, 2015 *Patrick* (A-2111), 2017–18 *Patrick* (A-2115–18); Pocono Lake Preserve, Pocono Lake, *F. Myers* (A-2213), 2065 *Patrick* (A-2182); South Pocono Lake, 2010 *Patrick* (A-2102); Tobyhanna Creek, 2032 *Patrick* (A-2140). Pike County: 2190 *Shulze* (A-2236); Greeley, 1 *Burke* (A-2184).

Pinnularia divergens v. **parallela** (Brun) Freng., 1924, Anales Soc. Cient. Argentina **97:** 102.

Pinnularia parallella (*divergens* W. Sm. var.) Brun, 1895, Le Diatomiste **2:** *pl. 14, fig. 7.*

This species was found twice but was not frequent in either locality.

Pike County: 129 *Shulze* (A-2219), 2190 *Shulze* (A-2236).

Pinnularia legumen Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin, **1841:** *pl. 4, fig. I, 7.*

This species is also mentioned in the Ber. K. Akad. Wiss. Berlin **1843:** 255, but is not described. There may be an earlier description which I have not found. I have checked this identification with Van Heurck's Type Slide no. 69.

This species was found only in one locality and then it was rare.

Pike County: Shohola Falls, 12 *Burke* (A-2205).

Pinnularia obscura Krasske, 1932, Hedwigia **72:** 117. *pl. 3, fig. 22.*

In his description Krasske states that the striae are 10 in 10 μ. In my specimen they are 12 in 10 μ, otherwise it is the same as Krasske's description. This species was found in only one locality but there it was very frequent.

Pike County: Greeley, 2 *Burke* (A-2188).

MAIORES Cleve subgenus

Pinnularia Clevii sp. nov.

PLATE III, FIGS. 7–10

Valvae bis constrictae, 112 μ longae, ad medium 16 μ latae; apicibus leviter rostratis; costis 9 in 10 μ, centro aliquid radiantibus, in apicibus convergentibus, area axiali lata, raphe simplice lata. **Type:** Monroe County: Jaggie's Bog, 263 *Shulze* (A-2225).

This species was first observed by P. T. Cleve and for that reason I am naming it after him. In 1891 (Acta Soc. pro Fauna et Flora Fennica **8** (2): 24. *pl. 1, fig. 3*) Cleve referred this species to *Pinnularia essox* Ehrenberg. An examination of Ehrenberg's original plate (Abhandl. K. Akad. Wiss. Berlin **1841:** *pl. I, fig. II, 4*) shows clearly that these two species are not the same. Ehrenberg's *Pinnularia essox* was no doubt the same as *Navicula essox* on H. L. Smith's Species Typicae No. 272. This species

really belongs to the genus *Caloneis*. I have included a copy of Ehrenberg's and Cleve's original figures. Also I have included a photograph of one of the specimens of H. L. Smith's Species Typicae No. 272.

This species was only found in one locality.

Monroe County: Jaggie's Bog, 262–63 *Shulze* (A-2223–2225).

Pinnularia maior (Kütz.) W. Sm., 1853, Brit. Diat., **1:** 54. *pl. 18, fig. 162.*

Frustulia maior Kütz., 1833, Syn. Diat., p. 547. *pl. 14, fig. 25.*

This species was found in several localities but was frequent in none.

Monroe County: Davy's Run, 2016 *Patrick* (A-2113); Pocono Lake Preserve, Pocono Lake, *F. Myers* (A-2213). Pike County: 2188–90 *Shulze* (A-2234–36); Greeley, 1 *Burke* (A-2184).

Pinnularia maior v. **transversa** (A. Schmidt) Cl., 1895, K. Sv. Vet. Akad. Handl. **27** (3): 90.

Navicula transversa A. Schmidt, 1876, Atlas Diat., *pl. 43, figs. 5, 6.*

This variety was rare in the localities where it was found.

Monroe County: Pocono Lake Preserve, Pocono Lake, *F. Myers* (A-2213). Pike County: 129 *Shulze* (A-2219), 2190 *Shulze* (A-2236).

COMPLEXAE Cleve subgenus

A. Striae usually 5 or less in 10 μ

  B. Valves broader at the middle and ends, thus producing a swollen appearance **P. nobilis**

  B. Valves linear with ends slightly narrower, but broadly rounded **P. streptoraphe**

B. Striae usually more than 6 in 10 μ

  C. Valves linear, with rounded ends; ends as broad if not broader than the rest of the valve ..... **P. gentilis**

  C. Valves linear or very slightly lanceolate, gradually diminishing in width towards the ends of the valve, thus producing in some cases a slightly elliptical effect, the band across the striae very variable as to its appearance **P. viridis** and vars.

Pinnularia gentilis (Donk.) Cl., 1895, K. Sv. Vet. Akad. Handl. **27** (3): 92.

Navicula gentilis Donk., 1870–73, Nat. Hist. Brit. Diat. p. 69. *pl. 12, fig. 1.*

This species was very frequent in Jaggie's Bog, Monroe County.

Monroe County: Jaggie's Bog, 262–63 *Shulze* (A-2223–25).

Pinnularia nobilis Ehr., 1840, Ber. K. Akad. Wiss. Berlin **1840:** 214.

This species was very frequent in a collection made by Shulze which was simply designated as Pike County. It was also common in a collection from Jaggie's Bog.

Monroe County: Jaggie's Bog, 263 *Shulze* (A-2225). Pike County: 128–29 *Shulze* (A-2217–19).

Pinnularia streptoraphe Cl., 1891, Acta Soc. pro Fauna et Flora Fennica **8** (2): 23.

This species was common in a collection made by Shulze which was simply designated as Pike County.

Monroe County: Pocono Lake Preserve, Pocono Lake, *F. Myers* (A-2213). Pike County: 128–29 *Shulze* (A-2217–19); Greeley, 1 *Burke* (A-2184).

Pinnularia viridis (Nitzsch) Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** *pl. 1, figs. I, 7; III, 3; IV, 3.*

Bacillaria viridis Nitzsch, 1817, N. Schrift. Naturf. Ges. Halle **3** (1): 99. *pl. 6, figs. 1–3.*

This species was very frequent in a composite sample of collections made by Myers from Pocono Lake. Actually it may not be so frequent in any single habitat.

Monroe County: Davy's Run, 2013–14 *Patrick* (A-2107–10); Jaggie's Bog, 263 *Shulze* (A-2225); Pocono Lake Preserve, Pocono Lake, *F. Myers* (A-2213); Wier Lake, 2046 *Hodge* (A-2169). Pike County: 127–29 *Shulze* (A-2215–19), 2188–90 *Shulze* (A-2234–36); Bushkill Creek, 1621 *Shulze* (A-2227); Shohola Falls, 3 *Burke* (A-2190), 12 *Burke* (A-2204).

Pinnularia viridis v. **elliptica** Meister, 1912, Beiträge zur Krypt.-Flora Schw., **4** (1): 150. *pl. 23, fig. 4.*

This variety occurred only in one locality and then it was rare.

Monroe County: Jaggie's Bog, 263 *Shulze* (A-2225).

Pinnularia viridis v. **fallax** Cl., 1895, K. Sv. Vet. Akad. Handl. **27** (3): 91.

This variety occurred only once and then it was rare.

Monroe County: Davy's Run, 2017 *Patrick* (A-2115).

Pinnularia viridis v. **sudetica** (Hilse) Hustedt *apud* Pascher, 1930, Süssw. Flora Mitteleurop. Heft 10: 335.

Pinnularia sudetica Hilse, 1860, Jahres-Berichte Schles. Ges. Väterl. Cult. **36:** 82.

As this name is older than *P. commutata* for this variety it is the one that should be used. It is doubtful to me that this form should be considered a variety of *viridis* because the raphe is simple instead of being complex as is characteristic for this group. However Grunow, Cleve, and Hustedt considered it to be. I have not as yet arrived at any definite conclusions.

This variety was very frequent in Lost Lake which is a strongly dystrophic *Sphagnum* bog.

Monroe County: Lost Lake, 2020 *Turner* (A-2121). Pike County: 129 *Shulze* (A-2219).

AMPHORA CLEVE

Amphora ovalis Kütz., 1844, Bacill., p. 107. *pl. 5, fig. 35.*

Frustulia ovalis Kütz., 1833, Linnaea **8:** 539. *pl. 13, fig. 5.*

Pike County: Shohola Falls, 10 *Burke* (A-2201).

Amphora ovalis v. **Pediculus** (Kütz.) Van Heurck, 1880, Syn. Diat. Belgique, *pl. 1, figs. 6, 7,* text (1885) p. 59.

Cymbella pediculus Kütz., 1844, Bacill., p. 80. *pl. 5, fig. 8.*

This variety, like the species, was not often found in this study. It was rare and found in only two localities.

Monroe County: Wier Lake, 2046 *Hodge* (A-2168). Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195).

Amphora perpusilla Grun., 1884, Denk. Akad. Wiss. Wien **48:** 50. *pl. 1, fig. 6.*

This species was rare in one locality.

Wayne County: Angels, 2021 *Burke and Patrick* (A-2123).

CYMBELLA AGARDH

A. Central nodule with an isolated stigma or the median striae ending in an isolated punctum at the central nodule
  B. Stigma present
    C. Stigma on dorsal side, valve more or less naviculoid with the ventral margin usually swollen at the central area.....**C. sinuata**
    C. Stigma on ventral side of central nodule, valve cymbelloid **C. tumida**
  B. Stigma not present, ventral striae ending in isolated puncti, in valve view distinctly cymbelloid in shape.....**C. cistula**

A. Central nodule without an isolated stigma, ventral striae at central nodule not ending in isolated puncti
  D. Valve view distinctly cymbelloid, raphe excentric
    E. Raphe forming a straight line usually quite close to the edge of the valve
      F. Striae distinctly lineolate, ventral edge of valve straight or somewhat convex at central nodule.....**C. turgida**
      F. Striae not distinctly lineolate
        G. Terminal nodules distant from the ends of the valves, the fissure of the terminal nodule prolonged at a slight angle to the general direction of the raphe **C. scotica**
        G. Terminal nodules near the ends of the valve, fissure not prolonged as above.....**C. ventricosa**
    E. Raphe somewhat curved or arched, more distant from the ventral margin .....**C. aspera**
  D. Valve more naviculoid in shape, raphe usually only slightly excentric
    H. Small forms with indistinct central area
      I. Striae 24 or more in 10 μ.....**C. microcephala**
      I. Striae typically less than 20 in 10 μ, raphe more excentric **C. amphicephala**
    H. Larger forms with distinct central area
      J. Striae less than 10 in 10 μ, valve elliptically lanceolate **C. Ehrenbergii**
      J. Striae more numerous
        K. Ends of valve produced, apiculate..**C. cuspidata**
        K. Ends of valve produced, capitate to rostrate **C. naviculiformis**
        K. Ends only slightly produced.....**C. Hauckii**

Cymbella amphicephala Naeg. *ex* Kütz., 1849, Spec. Algarum, p. 860.

This species was rare in the various habitats listed.

Monroe County: Davy's Run, 2015 *Patrick* (A-2111), 2056 *Patrick* (A-2180); Tobyhanna Creek, 2032 *Patrick* (A-2140), 2033 *Patrick* (A-2142); Wier Lake, 2046 *Hodge* (A-2169).

Cymbella aspera (Ehr.) Herib., 1893, Diat. Auvergne, p. 69. *pl. 3, fig. 10.*
Cocconeis aspera Ehr., 1839, Ber. K. Akad. Wiss. Berlin **1839:** 30.

Though found in two of the acid lakes, this species was very frequent only in Mountain Lake in which the pH is 7.3.

Monroe County: Mountain Lake, 2051 *Hodge* (A-2178); Pocono Lake, *F. Myers* (A-2213); Wier Lake, 2046 *Hodge* (A-2169).

Cymbella cistula (Ehr.) Kirchn., 1878, in F. Cohn's Kryptogamen-Flora von Schles., **2:** 189.
Cocconema cistula Ehr. *apud* Hempr. and Ehr., 1831, Symbolae Physicae: Animalia Evertebrata Exclusis Insectis — First Series, no page number, *pl. 2, fig. 10.*

Luzerne County: Harvey Lake, 2042 *Hodge* (A-2160). Monroe County: Popomoning Lake, 2045 *Hodge* (A-2167); Trout Lake, 2049 *Hodge* (A-2175).

Cymbella cuspidata Kütz., 1844, Bacill., p. 79. *pl. 3, fig. 40.*

Though found in many habitats, this species was always rare.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131); Pocono Lake Preserve, South Pocono Lake, 2010 *Patrick* (A-2101); Tobyhanna Creek, 2032 *Patrick* (A-2140); Pocono Lake, 2036 *Patrick* (A-2149); Wier Lake, 2046 *Hodge* (A-2169). Pike County: Shohola Falls, 10 *Burke* (A-2201), 12 *Burke* (A-2205); 130 *Shulze* (A-2221); Bushkill Creek, 1621 *Shulze* (A-2227).

Cymbella Ehrenbergii Kütz., 1844, Bacill., p. 79. *pl. 6, fig. 11.*

Monroe County: Davy's Run, 2019 *Patrick* (A-2119); Jaggie's Bog, 263 *Shulze* (A-2225).

Cymbella Hauckii Van Heurck in Hauck and Richter Phykotheka Universalis No. 147. (Reference checked for me by Dr. David H. Linder)

Pike County: Shohola Falls, 12 *Burke* (A-2204), 127 *Shulze* (A-2215), 128–130 *Shulze* (A-2217–21).

Cymbella microcephala Grun. *apud* Van Heurck 1880, *pl. 8, figs. 36–39,* text (1885) p. 63.

The identification of this species was checked with Van Heurck Type Slide 211. In both habitats in which this species was found, the water was approximately pH 7.

Luzerne County: Harvey Lake, 2042 *Hodge* (A-2160). Monroe County: Trout Lake, 2049 *Hodge* (A-2174).

Cymbella naviculiformis Auersw., 1861, in Rabenhorst Algen Europea, no. 1065.

This species though found in several habitats was always rare.

Monroe County: Davy's Run, 2014 *Patrick* (A-2110). Pike County: Shohola Falls, 12 *Burke* (A-2205), 127 *Shulze* (A-2215). Wayne County: Angels, 2021 *Burke* (A-2124).

Cymbella scotica W. Sm., 1853, Brit. Diat., **1:** 18. *pl. 2, fig. 25.*

This species is one of the most widely distributed of those found in this study. Its distribution in no way seems to be correlated with the acidity or alkalinity of the water. It was found in shallow water. It is of common occurrence only in Lake Pocono, and very frequent in Trout Lake.

Lackawanna County: Indian Lake, 2044 *Hodge* (A-2165). Luzerne County: Harvey Lake, 2042–43 *Hodge* (A-2160–62). Monroe County: Davy's Run, 2014 *Patrick* (A-2110), 2018 *Patrick* (A-2118), 2056 *Patrick* (A-2180); Pocono Lake Preserve, South Pocono Lake, 2010 *Patrick* (A-2101); Tobyhanna Creek, 2032–33 *Patrick* (A-2140–42); Pocono Lake, 2034–36 *Patrick* (A-2144–48); 2038 *Patrick* (A-2152), 2065 *Patrick* (A-2182). Pike County: 2188–89 *Shulze* (A-2234–35); Shohola Falls, 3 *Burke* (A-2190), 4 *Burke* (A-2192), 10–12 *Burke* (A-2201–05), 14 *Burke* (A-2208).

Cymbella sinuata Greg., 1856, Quart. Jour. Micros. Sci. **4:** 4. *pl. 1, fig. 17.*

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131). Wayne County: Angels, 2021–22 *Burke and Patrick* (A-2123–25).

Cymbella tumida (Bréb.) Van Heurck, 1880, Syn. Diat. Belgique, *pl. 2, fig. 10,* text (1885) p. 64.

Cocconema tumidum Bréb. *ex* Kütz., 1849, Spec. Algarum, p. 60.

The identification of this species has been checked with Van Heurck Type Slide no. 21. It was rare in the two localities given below.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195).

Cymbella turgida Greg., 1856, Quart. Jour. Micros. Sci. **4:** 5. *pl. 1, fig. 18.*

This species was rare in the various localities.

Monroe County: Trout Lake, 2049 *Hodge* (A-2174). Pike County: 2188–90 *Shulze* (A-2233, 2236).

Cymbella ventricosa Ag., 1830, Consp. Crit. Diat., part 1, p. 9.

This species, though found in many different habitats in this study, was only twice of very frequent occurrence, in Mountain Lake and in Shohola Falls.

Luzerne County: Harvey Lake, 2042 *Hodge* (A-2160). Monroe County: Davy's Run, 2014 *Patrick* (A-2110), 2016 *Patrick* (A-2113), 2018 *Patrick* (A-2117), 2056 *Patrick* (A-2180); Mountain Lake, 2051 *Hodge* (A-2178); Pocono Lake Preserve, Tobyhanna Creek, 2033 *Patrick* (A-2142); Mud

Run, 2031 *Hodge* (A-2138); Pocono Lake, 2034–36 *Patrick* (A-2144–48), 2065 *Patrick* (A-2182); Popomoning Lake, 2045 *Hodge* (A-2166); Raymondskill Falls, 2025 *Patrick* (A-2021); Trout Lake, 2049 *Hodge* (A-2174); Wier Lake, 2046–47 *Hodge* (A-2168–70). Pike County: 127 *Shulze* (A-2215), 130 *Shulze* (A-2221), 2190 *Shulze* (A-2236); Bushkill Creek, 1621 *Shulze* (A-2227); Shohola Falls, 3–4 *Burke* (A-2190–92), 10 *Burke* (A-2200), 11 *Burke* (A-2202), 14 *Burke* (A-2209), 15 *Burke* (A-2211), 2190 *Shulze* (A-2236), 127 *Shulze* (A-2215), 130 *Shulze* (A-2221); Bushkill Creek, 1621 *Shulze* (A-2227).

GOMPHONEMA AGARDH

All of the species of this genus which were found in this study belong to that section of the genus which is characterized by having a punctum ending one of the median striae or present in the central area.

A. Valve distinctly asymmetrical to the transverse axis of the valve, apices distinctly different
  B. Striae at center of valve alternately longer and shorter, thus producing a radiate effect ..... **G. constrictum**
  B. Striae not alternately longer and shorter at center of valve
    C. Valve broadest at apex of valve
      D. Valve distinctly constricted just below apex **G. acuminatum**
      D. Valve gradually tapering to opposite apex **G. augur**
    C. Valve broadest below apex of valve
      E. Apex wedge-shaped, somewhat apiculate . **G. turris**
      E. Apex distinctly capitate..... **G. sphaerophorum**

A. Valve, though asymmetrical to the transverse axis, with apices not so distinctly different as above
  F. Apices of valve acute, the valve narrow and somewhat delicate in appearance **G. gracile**
  F. Apices of valve obtuse..... **G. angustatum** var.
  F. Apices of valve capitate, valve not over 30 μ long..... **G. parvulum**

Gomphonema acuminatum Ehr., 1832, Abhandl. K. Wiss. Berlin **1831:** 88.

This species was rare in all localities cited.

Luzerne County: Harvey Lake, 2042 *Hodge* (A-2161). Monroe County: Popomoning Lake, 2045 *Hodge* (A-2166); Wier Lake, 2046 *Hodge* (A-2168). Pike County: 127 *Shulze* (A-2215); Bushkill Creek, 1623 *Shulze* (A-2231); Lake Wallenpaupek tributary, 5 *Burke* (A-2195).

Gomphonema acuminatum v. **coronatum** (Ehr.) Rabh., 1864, Flora Europaea Algarum, p. 290.

Gomphonema coronatum Ehrenberg, 1840, Ber. K. Akad. Wiss. Berlin **1840:** 211.

This species was only found in one locality and there it was rare.

Pike County: Bushkill Creek, 1621–23 *Shulze* (A-2227–31).

Gomphonema acuminatum v. **pusillum** Grun. *apud* Van Heurck, 1880, Syn. Diat. Belgique, *pl. 23, fig. 19.*

Monroe County: Popomoning Lake, 2045 *Hodge* (A-2167); Mountain Lake, 2051 *Hodge* (A-2178). Pike County: 130 *Shulze* (A-2221); Shohola Falls, 14 *Burke* (A-2209). Wayne County: Angels, 2021 *Burke and Patrick* (A-2123).

Gomphonema acuminatum v. **laticeps** (Ehr.) Grun. *apud* Van Heurck, 1880, Syn. Diat. Belgique, *pl. 23, fig. 17.*

Gomphonema laticeps Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin **1841:** 416.

This species was found in one habitat and there it was rare. It may well be a contamination from some other locality.

Monroe County: Mountain Lake, 2051 *Hodge* (A-2178).

Gomphonema angustatum v. **obtusatum** (Kütz.) Grun. *apud* Van Heurck, 1880, Syn. Diat. Belgique, *pl. 24, figs. 43–45.*

Sphenella obtusata Kütz., 1844, Bacill., p. 83. *pl. 9, fig. 1.*

Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195); Shohola Falls, 10 *Burke* (A-2201). Wayne County: Angels, 2021 *Burke and Patrick* (A-2123).

Gomphonema augur Ehr., 1840, Ber. K. Akad. Wiss. Berlin **1840:** 211.

This species was very frequent in the surface vegetation of Mountain Lake. The pH was 7.3.

Monroe County: Mountain Lake, 2051 *Hodge* (A-2178). Pike County: Shohola Falls, 12 *Burke* (A-2204).

Gomphonema constrictum Ehr., 1832, Abhandl. K. Akad. Wiss. Berlin **1830:** 63.

Luzerne County: Harvey Lake, 2042 *Hodge* (A-2160). Monroe County: Mountain Lake, 2051 *Hodge* (A-2178); Popomoning Lake, 2045 *Hodge* (A-2166).

Gomphonema constrictum v. **capitatum** (Ehr.) Van Heurck, 1880, Syn. Diat. Belgique, *pl. 23, fig. 7,* text (1885) p. 123.

Gomphonema capitatum Ehr., 1838, Die Infusionsthierchen als volkommene Organismen, p. 217. *pl. 18, fig. 2.*

Monroe County: Davy's Run, 2010 *Patrick* (A-2102), 2015 *Patrick* (A-2111), 2056 *Patrick* (A-2180); Mountain Lake, 2051 *Hodge* (A-2178); Pocono Lake Preserve, Pocono Lake, 2065 *Patrick* (A-2182); Tobyhanna Creek, 2032–33 *Patrick* (A-2140–42); Popomoning Lake, 2045 *Hodge* (A-2166); Trout Lake, 2049 *Hodge* (A-2174); Wier Lake, 2046 *Hodge* (A-2169). Pike County: 2188–90 *Shulze* (A-2233–36); Bushkill Creek, 1621 *Shulze* (A-2227); Shohola Falls, 3–4 *Burke* (A-2190–92), 10–12 *Burke* (A-2200–04).

Gomphonema gracile Ehr., 1838, Die Infusionsthierchen als volkommene Organismen, p. 217. *pl. 18, fig. 3.*

Though this species was found in several habitats, it was of frequent

occurrence only in Bushkill and Tobyhanna Creeks. My specimens correspond to those illustrated by Van Heurck in the Synopsis Diatomées Belgique, but they vary from the specimens on Cl. and Möll. Type Slide no. 274 in that the central areas of my specimens are more distinctly unilateral.

Northampton County: Green Pond, 2050 *Hodge* (A-2176). Monroe County: Tobyhanna Creek, 2033 *Patrick* (A-2142); Wier Lake, 2046–47 *Hodge* (A-2169–70). Pike County: Bushkill Creek, 1621–23 *Shulze* (A-2227–31); Shohola Falls, 14 *Burke* (A-2209).

Gomphonema gracile v. **auritum** (A. Braun) Grun. *apud* Van Heurck, 1880, Syn. Diat. Belgique, *pl. 24, fig. 15*, text (1885) p. 125.

Gomphonema auritum A. Braun *ex* Kütz., 1849, Spec. Algarum, p. 68.

I have checked these identifications against Van Heurck's Type Slide no. 212 and find that my specimens agree with this variety except in the structure of the central area. In my specimens the central area is more as v. *lanceolata*, but in other respects they seem to be v. *auritum*. No doubt they are an intermediate form. I refer to the specimens from Tobyhanna Creek. In the specimens from Bushkill Creek the striae are 9 in 10 μ. Those on Van Heurck's slide have 14 striae in 10 μ. However, Cleve (K. Sv. Vet. Akad. Handl. **26** (2): 182) states that this variation is possible.

Monroe County: Tobyhanna Creek, 2032 *Patrick* (A-2140). Pike County: Bushkill Creek, 1623 *Shulze* (A-2231).

Gomphonema gracile v. **naviculoides** (W. Sm.) Grun. *apud* Van Heurck, 1880, Syn. Diat. Belgique, *pl. 24, fig. 13*.

Gomphonema naviculoides W. Sm., 1856, Brit. Diat., **2**: 98.

This variety was very frequent once and then in very shallow water on the surface of leaves in a puddle at Angels near Mill Creek. The temperature of the water was between 50–60° F.

Pike County: Shohola Falls, 10 *Burke* (A-2201). Wayne County: Angels, 2024 *Burke and Patrick* (A-2129).

Gomphonema parvulum Kütz., 1849, Spec. Algarum, p. 65.

Sphenella ? parvula Kütz., 1844, Bacill., p. 83. *pl. 30, fig. 63*.

Hustedt states that this species prefers standing water. In this study it seemed to reach its best development and to be of very frequent occurrence in shallow, cool, swift, flowing water of Davy's Run and Mill Creek.

Monroe County: Davy's Run, 2015–16 *Patrick* (A-2111–13), 2019 *Patrick* (A-2119), 2056 *Patrick* (A-2180); Pocono Lake Preserve, Pocono Lake, Mud Run, 2031 *Hodge* (A-2138); Pocono Lake, 2036 *Patrick* (A-2148), 2065 *Patrick* (A-2182); Tobyhanna Creek, 2033 *Patrick* (A-2142); Trout Lake, 2049 *Hodge* (A-2175); Wier Lake, 2047 *Hodge* (A-2170). Pike County: 127 *Shulze* (A-2215); Bushkill Creek, 1623 *Shulze* (A-2231); Lake Wallenpaupek tributary, 5 *Burke* (A-2195); Shohola Falls, 3 *Burke* (A-2190), 10–11 *Burke* (A-2201–02). Wayne County: Angels, 2021 *Burke and Patrick* (A-2123), 2026 *Burke and Patrick* (A-2134).

Gomphonema parvulum v. **micropus** (Kütz.) Cl., 1894, K. Sv. Vet. Akad. Handl. **26** (2): 180.

Gomphonema micropus Kütz., 1844, Bacill., p. 84. *pl. 8, fig. 12.*

This variety was very frequent in only one locality, in Wayne County. The habitat was in very shallow water on the surface of leaves. The temperature of the water was between 50–60° F.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131). Wayne County: Angels, 2022–24 *Burke and Patrick* (A-2125–29).

Gomphonema sphaerophorum Ehr., 1845, Ber. K. Akad. Wiss. Berlin **1845:** 78.

This species was only found once and then it was rare.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131).

Gomphonema turris Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin, **1841:** 416.

Monroe County: Mountain Lake, 2051 *Hodge* (A-2178). Pike County: Shohola Falls, 10 *Burke* (A-2201).

CYSTOPLEURA BRÉBISSON

Cystopleura has to be used instead of *Epithemia* for the latter is preoccupied by a genus of flowering plants. Species of this genus were rarely found in this study and those noted below were rare in each of the localities.

Cystopleura turgida (Ehr.) Kuntze, 1891, Revis. Gen. Plant., **2:** 891.

Navicula turgida Ehr., 1832, Abhandl. K. Akad. Wiss. Berlin, **1830:** 64.

Monroe County: Mountain Lake, 2051 *Hodge* (A-2178).

Cystopleura Zebra v. **proboscidea** (Kütz.) De Toni, 1892, Sylloge Algarum (Bacill.) **2:** 784.

Epithemia proboscidea Kütz., 1844, Bacill., p. 35. *pl. 15, fig. 13.*

This identification has been checked with Van Heurck's Type Slide no. 254. My specimens are like the specimens on this slide except the ventral margin of the valve is straight instead of being slightly arched in the center.

Monroe County: Mountain Lake, 2051 *Hodge* (A-2178).

Cystopleura Zebra v. **saxonica** (Kütz.) De Toni, 1892, Sylloge Algarum (Bacill.) **2:** 784.

Epithemia saxonica Kütz., 1844, Bacill., p. 35. *pl. 5, fig. 15.*

Monroe County: Popomoning Lake, 2045 *Hodge* (A-2166).

RHOPALODIA O. MÜLLER

Rhopalodia gibba (Ehr.) Müll., 1897, Engler's Bot. Jahrb. **22:** 65. *pl. 1, figs. 15–17.*

Navicula gibba Ehr., 1832, Abhandl. K. Akad. Wiss. Berlin **1831:** 80.

This species, though found in several localities, was always rare.

Monroe County: Mountain Lake, 2051 *Hodge* (A-2178); Pocono Lake

Preserve, Pocono Lake, 2035 *Patrick* (A-2146). Northampton County: Green Pond, 2050 *Hodge* (A-2176).

HANTZSCHIA GRUNOW

Hantzschia amphioxys (Ehr.) Grun. *apud* Cl. and Grun., 1880, K. Sv. Vet. Akad. Handl. **17** (2): 103.

Eunotia amphioxys Ehr., 1843, Abhandl. K. Akad. Wiss. Berlin, **1841:** 413. *pl. 1, fig. I, 26.*

This species was only found once and then it was rare.
Pike County: 128 *Shulze* (A-2217).

Hantzschia elongata (Hantz.) Grun. *apud* Cl. and Grun., 1880, K. Sv. Vet. Akad. Handl. **17:** 104.

Nitzschia vivax v. *elongata* Hantz., 1860, Hedwigia **2**(6): 35–36. *pl. 6, fig. 5.*

In the text the citation is as given above. In the explanation of the plate it is cited as *Nitzschia elongata.*

This species was very frequent in Jaggie's Bog.

Monroe County: Jaggie's Bog, 263 *Shulze* (A-2225). Pike County: 128 *Shulze* (A-2217); Shohola Falls, 12 *Burke* (A-2204).

NITZSCHIA HASSALL

A. Frustule with middle part of valve spindle-shaped, ends long attenuate **Nitzschiellae**

A. Frustule not so formed

B. Keel punctae prolonged into ribs extending over the surface of the valve **Grunowiae**

B. Keel punctae not forming ribs, valve usually not constricted in the middle, valve usually lanceolate ..... **Lanceolatae**

GRUNOWIAE (Rabenhorst) Grunow

Nitzschia sinuata v. **Tabellaria** Grun. *apud* Van Heurck, 1881, Syn. Diat. Belgique, *pl. 60, figs. 12, 13,* text (1885) p. 176.

Denticula Tabellaria Grun., 1862, Verh. Zool. Bot. Ges. Wien **12:** 548. *pl. 18* (Grunow's *plate 12*) *fig. 26.*

I have checked this determination with Grunow's determination on Van Heurck's Type Slide no. 386.

This variety was frequent in a collection which was made by squeezing out plants of *Elodea* found in Popomoning Lake.

Monroe County: Popomoning Lake, 2045 *Hodge* (A-2166).

LANCEOLATAE Grunow

A. Striae less than 20 in 10 μ, distinctly punctate..... **N. amphibia**

A. Striae more than 24 in 10 μ, keel punctae 7–10 in 10 μ... **N. Hantzschiana** and vars.

A. Striae usually more than 30 in 10 μ, keel punctae 11 or more in 10 μ **N. palea**

Nitzschia amphibia Grun., 1862, Verh. Zool. Bot. Ges. Wien **12:** 574. *pl. 12, fig. 23.*

This species was found only once and then it was very rare.
Northampton County: Green Pond, 2050 *Hodge* (A-2176).

Nitzschia Hantzschiana Rabh., 1860, Hedwigia **2:** 40. *pl. 6, fig. 6.*

Rabenhorst refers one to his Algen Sachs. resp. Mitteleurop. no. 943, but no description is furnished. He simply compares this species to others.
This species was found only once but in that habitat it was common.
Pike County: Shohola Falls, 15 *Burke* (A-2211).

Nitzschia Hantzschiana f. **subserians** Grun. *apud* Van Heurck, 1881, Syn. Diat. Belgique, *pl. 69, fig. 2.*

This form was found in only one locality, but it was common there.
Pike County: Shohola Falls, 15 *Burke* (A-2211).

Nitzschia palea (Kütz.) W. Smith, 1856, Brit. Diat. **2:** 89.
Synedra palea Kütz., 1844, Bacill., p. 63. *pl. 3, fig. 27*; *pl. 4, fig. 2.*

This species was found in several habitats, but was common in only one locality, Green Pond, a body of water which has a higher mineral content than the other lakes or bodies of water that were studied.
Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131). Northampton County: Green Pond, 2050 *Hodge* (A-2176). Pike County: Shohola Falls, 3 *Burke* (A-2190), 10 *Burke* (A-2200).

Nitzschia palea v. **debilis** (Kütz.) Grun. *apud* Cl. and Grun., 1880, K. Sv. Vet. Akad. Handl. **17** (2): 96.
Synedra debilis Kütz., 1865, Bacill., 2d ed. p. 65. *pl. 3, fig. 45.*

This variety was found only once but there it was common. It was found associated with the species.
Northampton County: Green Pond, 2050 *Hodge* (A-2176).

Nitzschia palea v. **tenuirostris** Grun. *apud* Van Heurck, 1881, Syn. Diat. Belgique *pl. 69, fig. 31*, text (1885) p. 183.

This variety was found only twice and then it was rare.
Pike County: Shohola Falls, 4 *Burke* (A-2192), 11 *Burke* (A-2202).

NITZSCHIELLAE Rabenhorst

Nitzschia acicularis (Kütz.) W. Sm., 1853, Brit. Diat. I: 43. *pl. 15, fig. 122.*
Synedra acicularis Kütz., 1844, Bacill., p. 63. *pl. 4, fig. 3.*

The specimens found were smaller than usual, being 45 μ long and 2.3 μ wide. This species was only found in one locality, and then it was rare.
Pike County: Shohola Falls, 10 *Burke* (A-2200).

STENOPTEROBIA BRÉBISSON

Stenopterobia intermedia (Lewis) Van Heurck, 1896, Treatise on the Diatomaceae, p. 374.
Surirella intermedia Lewis, 1863, Proc. Acad. Nat. Sci. Phila. **15:** 338. *pl. 1, fig. 2.*

This species was rare in one collection which was designated by Shulze as Pike County.

Pike County: 127 *Shulze* (A-2215).

SURIRELLA TURPIN

A. Valves isopolar
  B. Wings clearly evident in valve view, caniculi 20 or less in 100 μ, valves linear lanceolate ..... **S. biseriata**
  B. Wings clearly evident in valve view, caniculi 30 in 100 μ, valves elliptical **S. Moelleriana**
  B. Wings not clearly evident in valve view
    C. Caniculi 50–60 in 100 μ, ends of valve rounded... **S. gracilis**
    C. Caniculi more than 60 in 100 μ, ends of valve somewhat wedge-shaped **S. angusta**

A. Valves heteropolar
  D. Wings not clearly developed in valve view, apparently marginal **S. guatemalensis**
  D. Wings clearly developed in valve view
    E. Frustule distinctly wedge-shaped in girdle view... **S. splendida**
    E. Frustule linear only slightly wedge-shaped in girdle view **S. tenera** and vars.

Surirella angusta Kütz., 1844, Bacill., p. 61. *pl. 30, fig. 52.*

Though found in several localities it was frequent in only one which was from squeezings of moss in Mud Run. From this study it would seem that this species preferred running water.

Monroe County: Davy's Run, 2015 *Patrick* (A-2111), 2017 *Patrick* (A-2115), 2056 *Patrick* (A-2180); Pocono Lake Preserve, Mud Run, 2031 *Hodge* (A-2138); Tobyhanna Creek, 2033 *Patrick* (A-2142); Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: Shohola Falls, 10–11 *Burke* (A-2201–03), 14 *Burke* (A-2210). Wayne County: Angels, 2022 *Burke and Patrick* (A-2125), 2026 *Burke and Patrick* (A-2134).

Surirella biseriata Bréb., 1836, Mem. Soc. Acad. Sci. Artes Belles Lettres de Falaise, **1835:** 53. *pl. 7.*

This species was found only once and then it was rare.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131).

Surirella gracilis (W. Sm.) Grun., 1862, Verh. Zool. Bot. Ges. Wien **12:** 450. *pl. 7* (Grunow's *plate 10*) *fig. 11.*

Tryblionella gracilis Smith, 1856, Brit. Diat., **2:** 35. *pl. 10, fig. 75.* (Grunow questions that this is the same.)

This species was found only once and then it was rare.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131).

Surirella guatemalensis Ehr., 1854, Mikrogeologie, *pl. 33, fig. VI, 7.*

This species has previously been reported from Massachusetts and Connecticut. It was only found once or twice in the collection. However, since

it is such a distinct species and one not to be confused with any other, I have decided to include it.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131).

Surirella Moelleriana Grun., 1870, Catalogue and "400" Type Plate of Moeller, 2–3–10.

As indicated above this species is recorded as a new species in the catalogue which accompanied Moeller's "400" Type Plate. It is stated that these identifications are according to the classification of Grunow. It has been generally assumed that the identifications were made by Grunow.

In some ways this species seems to be very similar to *Surirella Amphioxys* W. Smith, but until William Smith's slide is seen, this problem cannot be settled. Smith does not give a figure and his description is not complete enough to be definite.

This species was only found in one locality, but then it was of frequent occurrence.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131–33).

Surirella splendida Ehr., 1854, Mikrogeologie, *pl. 2, fig. III, 16, fig. XIV, 35, pl. 35, figs. A-1, F-6.*

This species was found only once and then it was rare.

Monroe County: Davy's Run, 2056 *Patrick* (A-2180).

Surirella tenera Greg., 1856, Quart. Jour. Micros. Sci. **4:** 11. *pl. 1, fig. 38.*

This species was found only once and then it was rare.

Monroe County: Davy's Run, 2019 *Patrick* (A-2119).

Surirella tenera v. **nervosa** A. Schmidt, 1875, Atlas Diatomaceen-Kunde, *pl. 23, figs. 15–17.*

This species was rare in the two localities cited below.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131). Pike County: Lake Wallenpaupek tributary, 5 *Burke* (A-2195).

Surirella tenera v. **Palmeri** (Boyer) Hustedt, 1927, in A. Schmidt's Atlas der Diatomaceen-Kunde, *pl. 366, fig. 4, 5.*

Surirella Palmeri Boyer, 1920, Bull. Torrey Bot. Club **47:** 70. *pl. 2, figs. 14, 15.*

This variety was fairly frequent in the one locality where it was found.

Monroe County: Raymondskill Falls, 2025 *Patrick* (A-2131).

ECOLOGICAL DISCUSSION

In the consideration of the ecological relations of the species studied, I have thought it wise to consider in detail only those species which were very frequent or common in a given habitat. It is the purpose of such an ecological discussion as this one to correlate the presence of certain species to given ecological conditions. Therefore if a species or variety is not well established in a given habitat, it cannot be typically indicative of the conditions present. It is in the taxonomic consideration that the detailed

distribution of each species is given. The pH range given in parenthesis is that which Krieger [1] has indicated for the species in question. A study of the various habitats shows the following relationships.

Lackawanna County: Indian Lake, altitude 1960 ft., pH 5–5.2, bicarbonates 8.5–11.6 p.p.m., calcium 1.54 p.p.m., color U.S.G.S. scale 10, length 0.7 kilometer. The flora was not very plentiful as to specimens or species in the collections made from this lake.

Luzerne County: Harvey Lake, Catskill formation, altitude 1230 ft., pH 7, bicarbonates 21.4–32.9 p.p.m., calcium 7.64 p.p.m., color U.S.G.S. scale 10. Length about 4 kilometers. This is the largest natural lake in Pennsylvania. It is a deep body of water of irregular outline formed by glacial action and is surrounded by wooded moraine and farming country. The principal aquatics are *Ceratophyllum demersum, Elodea canadensis, Fontinalis disticha, Megalodonta Beckii, Najas flexilis, Potamogeton perfoliatus, Potamogeton epihydrus, Potamogeton crispus, Ranunculus trichophyllus.* In the collections made from the bottom vegetation in shallow, still water, *Cyclotella compta* v. *radiosa* and *Cocconeis placentula* were the dominant forms. The collections made from the vegetation in running water at the outlet showed a more meager diatom flora.

Monroe County: Davy's Run, Pocono formation, is a mountain torrent arising on the Pocono Lake Preserve and emptying into Tobyhanna Creek. Its average pH is 5.8. The principal aquatic is *Fontinalis dalecartica.* The collections were made from several different habitats. In squeezings from *Hypnum* and *Fontinalis* growing in rapid water in deep shade, *Achnanthes linearis, Eunotia Meisteri, Fragilaria virescens* (pH 6.8–7.8), *Gomphonema parvulum* (pH 6.8–7.8), *Navicula Rotaeana, N. subatomoides* and *Tabellaria flocculosa* (pH 3.5–5.6) were very frequent in occurrence. Squeezings from *Fontinalis* growing in full sun in running water yielded most frequently *Achnanthes linearis, Eunotia pectinalis* (pH 6–7.8), *E. pectinalis* v. *minor, Navicula minima* v. *atomoides, N. Rotaeana* and *Vanheurckia rhomboides* v. *crassinervia* (pH 4–5.5). Though the observed average pH was 5.8, the species of most frequent occurrence had a minimum pH range of 3.5–6.8 and a maximum pH range of 5.5–7.8.

In a spring fed ditch six inches deep which runs along the path in the woods which leads to Davy's Run, *Vanheurckia rhomboides* v. *crassinervia* (pH 4–5.5) was commonly found. *Sphagnum* was also growing abundantly in the ditch.

Lost Lake, Pocono formation, is a strongly distrophic *Sphagnum* bog. The temperature of the water in July was between 50–60° F. The well-developed diatom flora consisted of relatively few species. Those of very frequent or common occurrence were *Eunotia robusta* (pH 4.5–5.5), *E. tautonensis, Pinnularia viridis* v. *sudetica, Vanheurckia rhomboides* and *V. rhomboides* v. *crassinervia* (pH 4–5.5). Noteworthy also was the frequent occurrence of *Asterionella Ralfsii* and the very frequent occurrence

[1] Krieger, W. 1929. Beiträge zur Naturdenkmalpflege **13** (2): 233–300.

of *Eunotia Naegelii*. The flora of this bog most nearly resembles that of Lake Tamaque which is also strongly distrophic.

Mountain Lake, Catskill formation, altitude 600 ft., length about 0.5 kilometer, pH 7–7.3, bicarbonates 41.5–68.3 p.p.m., calcium 11.71 p.p.m., color U.S.G.S. scale 25. This is a narrow pond formed by damming Pond Creek and is surrounded by open farm country. The principal aquatics are *Ceratophyllum demersum*, *Chara vulgaris*, *Elodea canadensis*, *Najas flexilis*, *Lemna minor*, and *Potamogeton epihydrus*. In the collections which were made from the surface vegetation, a well-diversified flora was present. Those species which were very frequent or abundant were *Cymbella aspera* (pH 6.8–7.8), *C. ventricosa* (pH 6.8–7.8), *Cocconeis placentula* (pH 6.8–7.8), *Eunotia monodon* v. *major*, *Gomphonema augur*, *Navicula radiosa* (pH 5–7.8) and *Synedra ulna* v. *danica*.

Pocono Lake Preserve is in the Pocono formation at an altitude of about 1640 ft. This is a large area in the Pocono Plateau which has been set aside by the state in order to preserve the native flora and fauna.

Mud Run is a small run on the preserve near Tobyhanna Creek. Squeezings from the moss growing in the spillway contained mainly *Tabellaria fenestrata* and *T. flocculosa* (pH 3.5–5.5). The pH at the time the collections were made was pH 5.2.

Pocono Lake, length about 5 kilometers, average pH 6.4, bicarbonates 15.9 p.p.m., calcium 2.37 p.p.m., color U.S.G.S. scale 40. Pocono Lake, surrounded by wooded country, is a long pond of irregular outline formed by damming Tobyhanna Creek. The principal aquatics are *Drepanocladus exannulatus* in large patches, *Eleocharis acicularis* lining areas of the shore, *Fontinalis disticha*, *Fontinalis novae-angliae*, *Myriophyllum humile* in large patches, *Najas flexilis*, *Nitella flexilis* in large patches, *Potamogeton epihydrus* adhering to submerged stumps and rocks, and *Sphagnum subsecundum*. Several collections were made from the shallow water in the vicinity of the Emlen dock. The piles supporting the dock were also scraped. The diatoms of very frequent or common occurrence were *Cymbella scotica* (pH 4.5–5.5), *Eunotia veneris* (pH 4.5–5.5), *Navicula radiosa* v. *tenella*, *Tabellaria fenestrata*, and *T. flocculosa* (pH 3.5–5.5), *Vanheurckia rhomboides* v. *crassinervia* (pH 4–5.5), and *V. rhomboides* v. *crassinervia* f. *capitata*. These findings according to the pH ranges of the species given by Krieger would mean a pH 3.5–5.5.

Collections were also made from that portion of the lake known as South Pocono Lake. The principal aquatic plant is *Sphagnum*. The pH varies from pH 5.2–5.9 depending on the direction of the wind. The main diatoms associated with the *Sphagnum* were *Eunotia robusta* (pH 4.5–5.5) and *Vanheurckia rhomboides* v. *crassinervia* (pH 4–5.5). The two diatoms were also commonly associated with *Sphagnum* in Lost Lake.

In Spring Run which empties into Pocono Lake, *Eunotia microcephala* and *E. veneris* (pH 4.5–5.5) were commonly found. The water in this run is very shallow.

Tobyhanna Creek is a rapid mountain stream from the damming of

which Pocono Lake is formed. Below the dam the stream continues and empties into the Lehigh River at Stoddartsville, Luzerne County. Collections were made from the shallow water near the banks a few hundred feet below the dam. The pH of the water was 6.4. The most common species were *Tabellaria fenestrata*, and *T. flocculosa* (pH 3.5–5.5). However a fairly diverse flora is present. The common occurrence of *Tabellaria flocculosa* at this pH is somewhat higher than typical for the species. Perhaps there is some other more important factor than pH for the successful development of this species.

Popomoning Lake (Sailor's Lake) is in Chemung formation at an altitude of 660 ft., and is about 0.7 kilometer long, pH 8–8.1, bicarbonates 33.6–34.2 p.p.m., calcium 8.82 p.p.m., color U.S.G.S. scale 15. This is a deep body of water, ovoid in shape, formed by glaciation and is surrounded by hilly wooded moraines. The principal aquatics are *Elodea canadensis*, *Najas flexilis*, and *Potamogeton foliosus*. Squeezings from the aquatics, particularly *Elodea*, yielded a fairly diverse flora with *Eunotia veneris* (pH 4.5–5.5) and *Cocconeis placentula* (pH 6.8–7.8) the principal species. Noteworthy was the frequent occurrence of *Nitzschia sinuata* v. *Tabellaria*. This was the only locality where this species was found in this study. The finding of *Eunotia veneris* in this lake was very contrary to expectations as far as pH is concerned.

Lake Tamaque is in the Pocono formation at an altitude of 1800 ft., length about 0.4 kilometer, pH 3.8–4.2, bicarbonates 6.1 p.p.m., calcium 1.21 p.p.m., color U.S.G.S. scale 170. This round pond, surrounded by hills and low forest, is formed by the damming of Beaver Creek. It is strongly distrophic. The principal aquatics are *Cladopodiella fluitans*, *Fontinalis disticha*, *Fontinalis novae-angliae*, *Myriophyllum humile*, *Sphagnum cuspidatum*, and *Utricularia vulgaris*. The flora is limited to a very few species. The most common is *Vanheurckia rhomboides* v. *crassinervia*, and of very frequent occurrence is *Pinnularia Hilseana*. In the collections taken from surface scum, *Asterionella Ralfsii* was also of common occurrence. Notable was the very frequent occurrence of *Eunotia Naegelii*. From this study it would appear that *Asterionella Ralfsii* and *Eunotia Naegelii* prefer strongly distrophic water.

Trout Lake, Pocono formation, altitude 960 ft., length about 1 kilometer, pH 6.8, bicarbonates 12.2–15.8 p.p.m., calcium 2.57 p.p.m., color U.S.G.S. scale 10. Trout Lake is an oblong pond formed by the damming of Mountain Spring Creek and is surrounded by open farming land. The principal aquatics are *Elodea canadensis*, *Najas flexilis*, and *Potamogeton epihydrus*. The diatom flora was relatively richer in *Navicula* than that of other lakes studied. The flora was fairly well diversified. The most frequent species encountered were *Cymbella scotica* (pH 4.5–5.5) and *Navicula radiosa* v. *tenella*. The finding of *Cymbella scotica* at this pH is contrary to the findings of Krieger who lists this species under the name *Cymbella gracilis*, which I have previously shown to be an invalid name for this species.

Wier Lake, Catskill formation, altitude 700 ft., length about 0.2 kilo-

meter, pH 6.6–6.8, bicarbonates 17.1–19.5 p.p.m., calcium 3 p.p.m., color U.S.G.S. scale 10. This is a roundish pond formed by damming Wier Creek which is surrounded by fairly level farming country. The principal aquatics are *Elodea canadensis*, *Fontinalis antipyretica*, and *Fontinalis disticha*. The flora is well developed as to species and specimens. In squeezings from the surface vegetation, *Eunotia monodon* v. *major*, *Stauroneis phoenicenteron* (pH 6.8–7.8), and *Synedra ulna* (pH 6.8–7.8) were of common occurrence. In collections taken from the bottom vegetation in shallow water, *Fragilaria bicapitata*, *F. elliptica*, *Navicula minima* v. *atomoides*, and *Odontidium hiemale* v. *mesodon* were very frequent or common.

Northampton County: Green Pond, Martensburg shale formation, altitude 400 ft., length about 0.1 kilometer, pH 8–8.1, bicarbonates 117.1–137.3 p.p.m., calcium 35.8 p.p.m., color U.S.G.S. scale 50. This is a small roundish body of water which is formed from old wells and springs in the center. It is surrounded by open farming country. The principal aquatic is *Najas flexilis*. As seen by the water analysis, this pond has a higher mineral content than any of the other bodies of water which were analyzed. As might be expected, the diatom flora has a decidedly different aspect than that of the other bodies of water studied. The flora is less diversified and the dominant species is *Nitzschia palea* and its variety, *debilis*.

Pike County: Bushkill Creek is located on the Catskill formation. As Bushkill Creek runs through both Pike and Monroe Counties it is doubtful in which county these collections were made. Mr. Shulze is dead and no one seems to know just where he collected. The collections were made in a spring on Bushkill Creek opposite the head of an island. A well-developed diatom flora is present. The genus *Eunotia* is the dominant genus, and the species of common or very frequent occurrence are *Eunotia flexuosa*, *Eunotia lunaris* (pH 4–7.8), *Eunotia pectinalis* (pH 6–7.8), and *Eunotia pectinalis* v. *undulata*. Thus it would seem from the diatoms that the pH was probably between 6–7.8.

The swamp at Greeley is on the Catskill formation. Collections from *Fontinalis* in the brook running through the swamp contained a flora fairly rich in *Eunotia* and *Pinnularia*. However, the only two species of very frequent occurrence were *Fragilaria virescens* (pH 6.8–7.8) and *Meridion circulare* (pH 6.8–7.8). Collections from *Sphagnum* were also rich in *Eunotia*. The most frequent species were *Eunotia septentrionalis*, *E. tenella*, *Navicula festiva*, and *Pinnularia obscura*.

The collections made at Shohola Falls, which is on the Catskill formation, were from a variety of habitats offered by a pond, a brook, and a fall. Also just below the falls is a gorge in a limestone outcrop. The flora in the gorge is distinctly different from that found in the other habitats of this region. In collections taken from the edge of the pond above the falls, the following species were common or very frequent, *Eunotia flexuosa*, *E. lunaris* (pH 4–7.8), *Melosira italica* (pH 6.5–7.8), *Tabellaria fenestrata*, and *Tabellaria flocculosa* (pH 3.5–5.5). From the moss and algae in the brook

the following species were very frequent or common: *Cymbella ventricosa* (pH 6.8–7.8), *Eunotia lunaris* (pH 4–7.8), *Eunotia veneris* (pH 4.6–5.5), *Fragilaria crotonensis*, and *Synedra ulna* v. *danica*. From the moss in swift water at the top of the falls, the species of very frequent occurrence were *Cocconeis placentula* v. *lineata* (pH 6.8–7.8), *Eunotia pectinalis* v. *undulata*, *Navicula radiosa* v. *tenella*, and *Synedra ulna* v. *danica*. In the algae at the top of the falls, the species of very frequent occurrence were *Eunotia veneris* (pH 4.5–5.5), *Meridion circulare* (pH 6.8–7.8), and *Navicula radiosa* v. *tenella*. In the scrapings from dripping rocks to one side of the falls the species of very frequent occurrence were *Eunotia lunaris* (pH 4–7.8), *E. pectinalis*, *E. pectinalis* v. *undulata*, *E. veneris* (pH 4.6–5.5), *Meridion circulare* (pH 6.8–7.8), *Navicula minima* v. *atomoides*, *Navicula placentula*, *Tabellaria fenestrata*, and *T. flocculosa* (pH 3.5–5.5).

Below Shohola Falls there is a limestone outcrop. The diatom flora found here is different from that of other habitats and clearly reflects the difference of its geological and ecological environment. Collections made from the dripping rocks facing the falls contained mainly *Nitzschia Hantzschiana*, and *Nitzschia Hantzschiana* f. *subserians*. Other collections made from dripping rocks of the side wall of the gorge further down stream but above the concrete bridge, contained as the dominant species: *Eunotia lunaris* (pH 4–7.8), *Melosira roeseana* v. *epidendron*, *Navicula Keeleyi*, and *Navicula perpusilla* (pH 6.8–7.8).

Wayne County: Mill Creek, altitude 1800 ft. Mill Creek is a rapid mountain stream located in the Catskill formation, and empties into the Paupack Creek. Enmeshed in the moss growing in the cool, shallow, swift water in the middle of the creek, *Achnanthes lanceolata* (pH 6.8–7.8), *Gomphonema parvulum* (pH 6.8–7.8) and *Meridion circulare* (pH 6.8–7.8) were very frequent. Growing on the stones in the swift water in the middle of the creek was *Cocconeis placentula* v. *lineatus* which was of very frequent occurrence. In the slow running water of a shallow tributary of Mill Creek, *Achnanthes lanceolata* (pH 6.8–7.8), *Meridion circulare* (pH 6.8–7.8), *Odontidium hiemale* v. *mesodon*, *Synedra ulna* v. *danica* and *Vanheurckia rhomboides* v. *amphipleuroides* were of very frequent occurrence. From the surface of dead leaves in very shallow water, *Achnanthes lanceolata* (pH 6.8–7.8), *Fragilaria virescens* (pH 6.8–7.8), *Gomphonema gracile* v. *naviculoides* (pH 4.5–5.6), *Gomphonema parvulum* v. *micropus*, *Meridion circulare* v. *constricta* and *Odontidium anceps* were very frequent. The temperature of the water was between 50–60° F.

It is interesting to note that though geographically these habitats are relatively close together, the dominant species are so variable. This is but another indication of how dependent the luxurious growth of a diatom is upon its immediate ecological habitat. Thus the more accurate information we have as to the requirements of each species the more valuable the diatom will be as an indicator of water conditions.

As pointed out by Hustedt,[2] certain diatoms seem to be found typically associated with moss. In this study *Eunotia Meisteri*, *E. microcephala*, *Fragilaria virescens*, *Navicula Rotaeana* and *Navicula subatomoides* were most often associated with *Hypnum* and *Fontinalis*. Those species which reached their best development in association with *Sphagnum* were *Eunotia robusta*, *Vanheurckia rhomboides* v. *crassinervia*, *Navicula festiva*, *N. quadripartita* and *Pinnularia obscura*. This study supports the conclusions of Hustedt that they are typically aerophils as usually the moss was in a partially submerged habitat. In this group of aerophils is *Fragilaria bicapitata*, but in this study it was not found typically associated with moss. Other diatoms found in this study which seem to flourish in moss on dripping rocks or in partially submerged habitats are *Melosira roeseana* v. *epidendron*, *Navicula Keeleyi* and *Tabellaria flocculosa*.

The genus *Vanheurckia* is interesting as an acidophil group. *Vanheurckia rhomboides* and *V. rhomboides* v. *crassinervia*, and *V. rhomboides* v. *crassinervia* f. *capitata* are found in various habitats. *V. rhomboides* v. *crassinervia* is one of the few diatoms which seems to thrive in strongly acid or distrophic water. *V. rhomboides* v. *amphipleuroides* on the other hand reaches its best development in much less acid water.

Three other diatoms which seem to reach their best development in strongly distrophic conditions are *Pinnularia Hilseana*, *Asterionella Ralfsii* and *Eunotia Naegeli*.

On the other hand *Nitzschia palea* and *Nitzschia palea* v. *debilis* were only found under alkaline conditions. Likewise *Nitzschia Hantzschiana* v. *subserians* was only found in association with a limestone outcrop. It might appear that *Melosira roeseana* v. *epidendron* also prefers water of a high mineral content. However, Mr. F. J. Keeley tells me that he has found *Melosira roeseana* v. *epidendron* growing on crystalline rocks. He believes that it is the habitat of dripping rocks in association with moss that is the crucial point.

Certain diatoms considered in this study were most typically found growing on rocks in shallow water. *Achnanthes lanceolatum*, *Cocconeis placentula* v. *lineata*, and *Gomphonema parvulum* seemed to prefer rocks in swift water, while *Navicula perpusilla* reached its best development on dripping rocks.

Interesting also was the very frequent occurrence of *Synedra ulna* v. *danica* in the running water of brooks. This variety has most often been reported in the flora of lakes or ponds.

It will be noted that in some cases the water was studied from a chemical standpoint. These were the bodies of water which Myers (Proc. Acad. Nat. Sci. Phila. **94:** 251–287. 1942) studied particularly in his work on the rotifers of this region. The chemical analyses were made to determine the pH, the amount of bicarbonates, and calcium. The richest diatom flora as to number of species present was between the pH ranges of 6.4–7.3. Lake

[2] Hustedt, F., 1934. Abhandlungen und Vorträge herausgegeben von der Bremer Wissenschaftlichen Gesellschaft. **8/9:** (1934) 362–403.

Tamaque with a pH of 3.8–4.2, on the other hand, had a well-developed flora consisting of only a few species. The same tendency as to fewness of species was also noted in Green Pond with a pH of 8–8.1.

It is interesting to compare the floras of Green Pond and Lake Popomoning. Both bodies of water have a pH of 8–8.1, but the mineral content of the water of Green Pond, as seen by the bicarbonate and calcium determinations, is much greater. The diatom floras are also distinctly different. As might be expected this would seem to indicate that the type of diatom flora is more closely correlated to mineral content than to pH.

As the waters considered in this study are mostly acid, it is interesting to compare them with the acid water floras of New Jersey. Though similar in many respects, certain apparent lacks are of interest. For instance the genus *Anomoeoneis*, so commonly found in New Jersey, was not found in this study. Also certain species of *Surirella* described by Lewis from the White Mountains and frequently found in New Jersey were scarcely present in this study. Also the diatom *Tibiella punctata*, which is characteristically found in New Jersey was only found once, in Pocono Lake. This record was not included, as I believe it might have been contamination since the collection was made with apparatus often used in New Jersey. However, I must add that there is no reason so far as I know why it should not be found in the Pocono region.

Interesting also to note is the occurrence of *Eunotia tautonensis* which was originally found in New England and to date has not been reported from New Jersey.

Generally speaking the diatom flora is that of a cool temperate region. It contains more species common to northern or mountainous regions than to the more moderate temperate regions.

SUMMARY

In this study two hundred forty-eight nomenclatorial entities were considered and studied. Fifteen of these are new.

The names of three species and one variety were validated by supplying an adequate description.

The ecological factors which seem to be beneficial to the development of the various species have been considered in the ecological discussion.

As this study is mostly concerned with the study of the diatom floras in moss and more or less acid water, the genera *Eunotia*, *Tabellaria*, *Vanheurckia* and certain sections of the genus *Navicula* are most abundant from a quantitative and qualitative standpoint. The genus *Pinnularia* reaches its best development in collections from Pike County, particularly in those collections made by Shulze. However, two Monroe County habitats — Pocono Lake and Jaggie's Bog — have a fairly rich *Pinnularia* flora. Several genera such as *Achnanthes*, *Cymbella*, *Gomphonema*, *Neidium* and *Surirella* are fairly well represented as to number of species present, but seldom are these species of very frequent or common occurrence in the flora.

As might be expected, the genera *Amphora*, *Diploneis* and *Nitzschia* are

not well represented. Species of the genus *Nitzschia* are common only in Green Pond and in moss at the limestone outcrop below Shohola Falls, which have a relatively high mineral content.

It is interesting to note the complete absence of the genus *Anomoeneis*, *Tibiella*, and some of the species of *Surirella* which are often found in acid water floras. Likewise some of the species of the genera *Cystopleura* and *Rhopalodia*, which are considered by some to be aerophils, are poorly represented.

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PLATE I

1. Eunotia tenella (Grun.) Hustedt x2000
2, 3. Achnanthes Lewisiana sp. nov. x2633
4, 5. Achnanthes lanceolata v. apiculata var. nov. x2500
6, 7. Achnanthes Oestrupii v. parvula var. nov. x2617
8. Navicula exigua v. capitata x2100

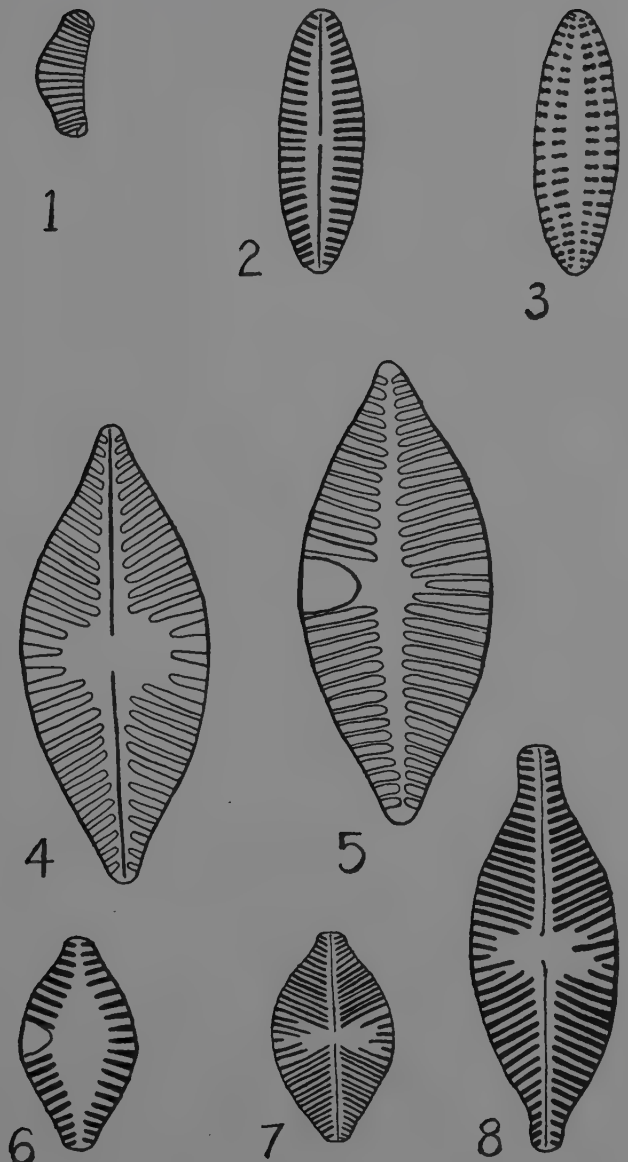

PLATE I

PLATE II

1. Achnanthes Stewartii sp. nov. x3031
2. Achnanthes Stewartii sp. nov. x1719
3. Achnanthes Stewartii sp. nov. x2200
4. Caloneis Lewisii sp. nov. x2100
5. Navicula poconoensis sp. nov. x2537
6. Navicula concava sp. nov. x2036
7. Navicula Keeleyi sp. nov. x2160

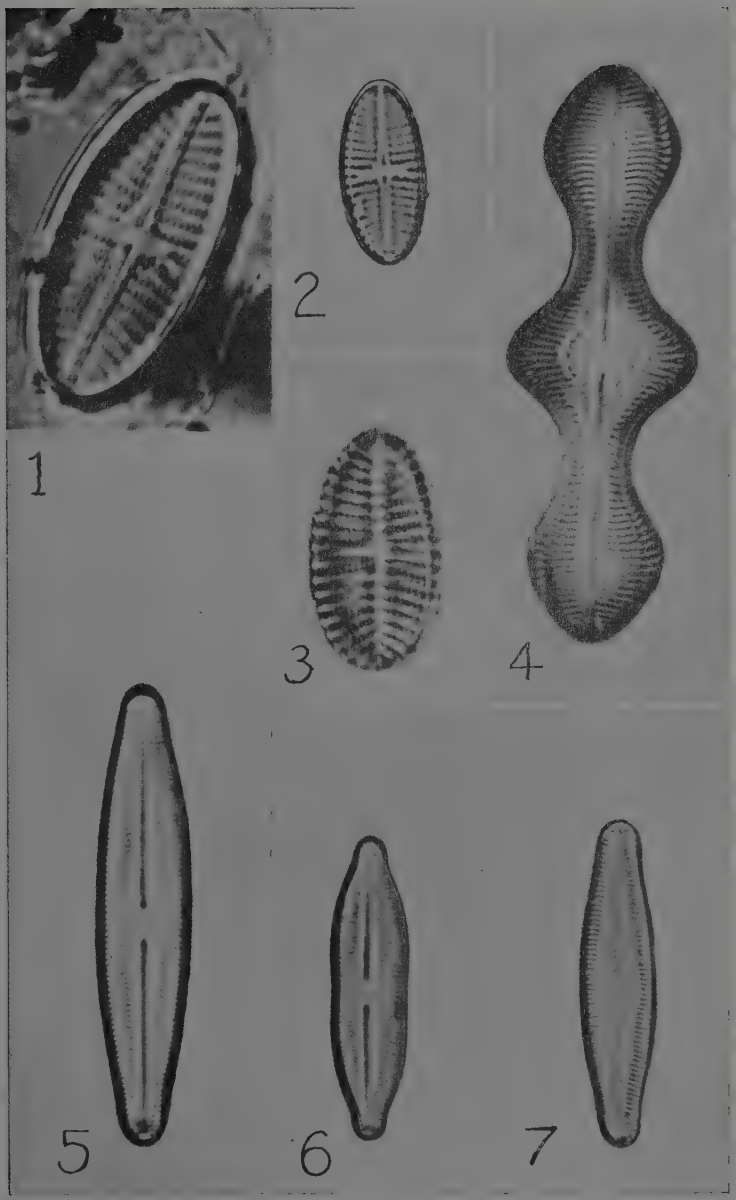

PLATE II

PLATE III

1. Pinnularia Burkii sp. nov. x2526
2, 3, 5. Pinnularia gibba, Ehrenberg's illustration x300
4. Stauroptera gibba, Ehrenberg's illustration x300
6. Pinnularia gibba v. rostrata var. nov. x1500
7. Pinnularia essox as on H. L. Smith's slide x800
8. Pinnularia essox, Ehrenberg's illustration x300
9. Pinnularia Clevei sp. nov. x598
10. Pinnularia essox as illustrated by Cleve x500

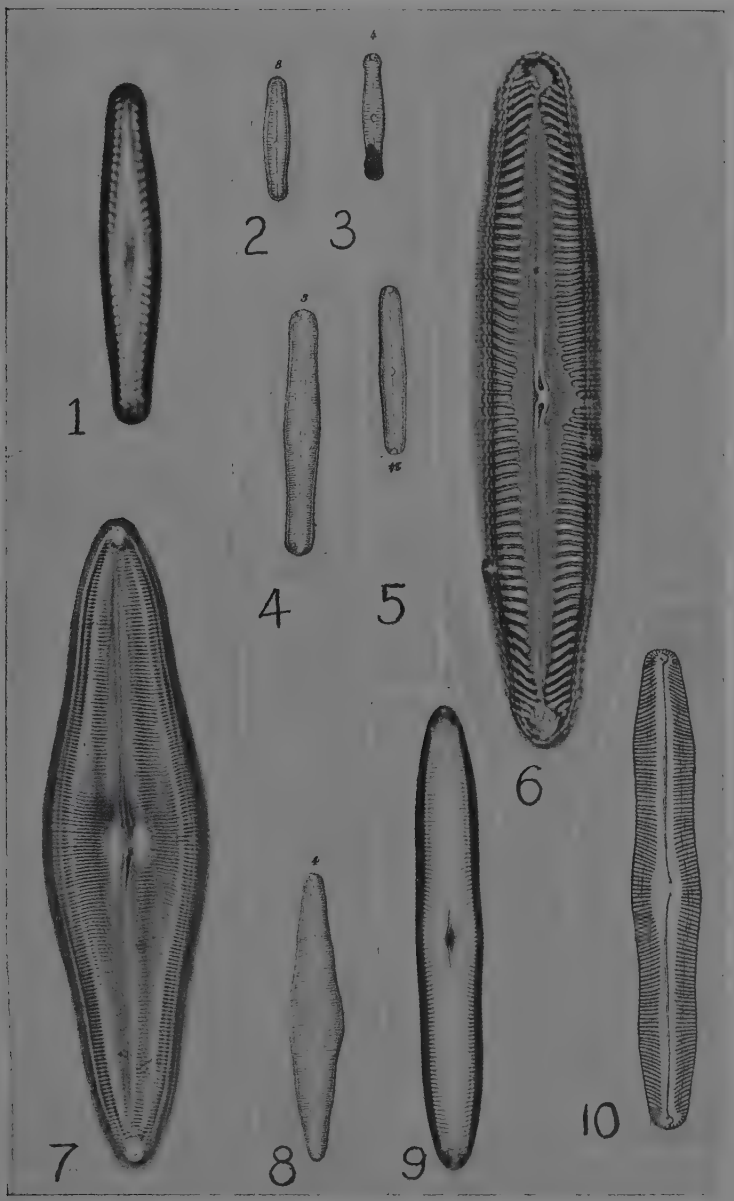

PLATE III

2(2):223–303 FARLOWIA JULY, 1945

THE BOLETINEAE OF FLORIDA WITH NOTES ON EXTRALIMITAL SPECIES

II. THE BOLETACEAE (GYROPOROIDEAE)

R. SINGER

The Boletaceae are the largest family of the suborder Boletineae. Much attention has been paid to them since Linné's day because of their edible qualities. In recent years the practical aspect has shifted to another problem, their physiological relationships with forest trees, and the economic significance of mycorrhizal symbiosis in forestry. It is obvious that no actual progress toward practical evaluation of the complicated biology of the mycorrhiza will be made without a profound knowledge of the taxonomy of the Boletaceae and extensive, accurate field observations concerning their ecological characters.

The present paper is an attempt to contribute to the knowledge of the Boletaceae of the state of Florida. Being a continuation of the first part treating the Strobilomycetaceae of Florida,[1] this article is based upon the same concept as the foregoing part, and the reader is referred to the introduction to that paper.

BOLETACEAE R. Maire (1901)

Characters of the family: Pileus scaly, fibrillose, mealy, tomentose, granulose, velutinous, or glabrous, often becoming tessellate-rimose, viscid or dry, small to large, the margin sometimes projecting; hymenophore tubulose, rarely lamellate (in *Phylloporus*); tubes short to long, decurrent or adnate to depressed around the stipe, or free; pores very small or closed when quite young to very wide and open from the beginning, sometimes lamellately arranged ("boletinoid"), and then not so easily separated from the context of the pileus, usually very easily separable from the context, in one genus (*Ixechinus*), all the single tubes free from each other, discolorous, or more frequently concolorous with the pores, whitish to sordid, or whitish to yellowish, or yellow to golden yellow, more rarely orange or red, the pores sometimes orange to red or reddish brown, at last often olivaceous or yellowish brown, sometimes becoming dirty livid or brownish or blue to green on pressure; spore print olivaceous to deep olivaceous, cinnamon, or fawn color to vinaceous pink, or ochraceous, or lemon yellow; spores usually not very richly colored under the microscope even when quite mature (except in *Xanthoconium* where they are bright golden), most fre-

[1] Singer, R. The Boletineae of Florida with notes on extralimital species. I. Farlowia 2 (1): 97–141. 1945.

quently pale melleous to melleous or brownish melleous, or pale yellowish, even hyaline, always smooth with homogeneous walls which rarely reach 1 μ in diameter, their length rarely over 20 μ, usually well below 20 μ, without germinative pore, with globose, subglobose, short-ellipsoid, fusoid-subcylindric, fusoid-ellipsoid, ovoid-fusoid, or cylindric outline; basidia and cystidia usually comparatively small, more rarely large; trama of the tube walls more or less bilateral in youth, in some genera (*Phylloporus*, *Xerocomus*) subregular, without an interlaced hymenopodium; hyphae with or without clamp connections; stipe cylindric, attenuate or thickened toward the base, or ventricose to bulbous, smooth, and glabrous or ornamented with glandulae, with furfuraceous floccons, with scabrous squamulae, or with reticulate lines, solid to hollow; veil often present, and then membranaceous, or membranaceous-floccose, or glutinous, or pulverulent (and then mostly yellow), either fugacious or persistent as an annulus on the stipe; habitat: on earth, more rarely on decayed wood in wooded areas, one species (*Xerocomus parasiticus*) parasitic on *Scleroderma*, the majority symbiotic with forest trees, forming mycorrhiza. Type genus *Boletus* Dill. *ex* Fr.

It has already become a commonplace to state the desirability of a partition of the once all-embracing genus *Boletus* into smaller units. Yet the existing schemes proposed by W. A. Murrill and E. Gilbert respectively (the remaining classifications are either stubbornly Friesian, or they have not been accepted by the mycologists, or they are merely variations of Gilbert's arrangement) were satisfactory only in a very limited way. Murrill's classification was satisfactory at a time when a system had to be mainly workable, i.e. an easy road leading to a generic name. While Murrill's classification was mostly original, Gilbert's scheme is merely an emendation and modernization of Quélet's classification (1886–1888). Although Gilbert expressly detests the evolutionary approach, he is more alluring to the phylogenetically minded modern mycologist because, at the expense of clear-cut divisions, he reunites mostly natural groups, or, at least, seems to have the tendency to do so. The real test came when additional anatomical and also chemical [2] characters were used to check on its principles and on its definition of genera, and when more facts on the richer boletaceous flora of North America and other extra-European regions became available to test its value. It cannot be denied that after careful examination of the resulting data, most of Gilbert's definitions and some of his genera have become untenable; others are complex or collective, and many of the species cited by him will have to be transferred to other groups than those designated for them by that author. As a whole, Gilbert's classification, quite in contrast to its author's claim, is a locally limited or, more accurately, a European system. When checked merely with European material, and by using only the limited number of characters admitted by Gilbert, it does

[2] Since chemical characters are not available for all species of the Boletaceae, they do not appear much in the keys of this paper. I expect them, however, gradually to take an important place in scientific keys to genera as well as to the sections and species.

not reveal many weak points, however, and this is the reason why it has been adopted with some modifications by most French authors, by this writer in his "System der Agaricales," and, in the absence of anything better, even by the most competent American specialist, W. H. Snell (Mycologia **33:** 415. 1941).

The first step toward a more universal solution, based not only on macroscopical and spore characters but on all anatomical, chemical and physiological characters available, was made by this writer in his essay on a group of genera he had studied in Siberia and compared with European and North American species: *Suillus (Ixocomus), Boletinus, Phylloporus, Gyrodon.*[3] *Gyroporus* is an easily defined genus. Consequently there was left mainly the genus-complex around *Boletus sensu stricto*, i.e. the genera *Xerocomus, Pulveroboletus, Boletus, Tylopilus, Leccinum,* and besides some genera that had more recently been described from the tropics and subtropics: *Gastroboletus, Phlebopus, Ixechinus, Boletochaete, Phaeogyroporus,* and *Xanthoconium.* As for the genera *Phlebopus, Phaeogyroporus,* and *Xanthoconium,* the author was able to secure all data necessary to insert these genera in any new classification; the genera *Gastroboletus, Ixechinus,* and *Boletochaete,* however, are in need of one or two descriptive details in order to receive their place in the system. We have attempted to reorganize the species belonging to all the above-mentioned genera in order to make these genera more natural and, at the same time, provide a more precise delimitation between them enabling the student actually to determine the genus prior to determining the species. These determinations are not easy, for in order to get down to the name, it is necessary to provide many more data on a given specimen than was hitherto required. But, provided the data are available, no guesswork will be necessary, and the keys should lead smoothly to the correct genus and species. The delimitation of the genera will be more fully discussed in its proper place. In the end, no verbal justification will make a classification acceptable. The actual test will be in the laboratories and herbaria. In order not to complicate unnecessarily the determination of the genera of Florida boletes by providing one key to all known genera, we thought it wise to add a second key for use in Florida only. This latter key is partly artificial, and takes into consideration only the characters of species treated as occurring in Florida in this paper.

SURVEY OF THE SUBFAMILIES AND GENERA OF THE BOLETACEAE

A. Group of genera imperfectly known but admitted because of the presence of some important character or correlated characters. (See B1, B2, B3)

B 1. Setae present in the hymenium. Africa and Asia.	*Boletochaete*
B 2. Tubes separated from each other, free. Madagascar.	*Ixechinus*

[3] Singer, R. Les genres Ixocomus, Boletinus, Phylloporus, Gyrodon et Gomphidius. Rev. de Mycol. **3:** 35–53, 157–177. pl. 4. 1938.

B 3. At least part of the surface layer of the pileus and the stipe connected and including the young hymenophore like a peridium. South-China.
Gastroboletus

A. Genera completely known anatomically and chemically, not showing any of the characters indicated under B1, B2, or B3.

C. Clamp connections constantly present except in occasional parthenogenetic forms, and easy to observe on at least a fair percentage of the septa[4] (Species with elongate spores *and* large incrusted cystidia, forming mycorrhiza with conifers, and macroscopically characterized by having boletinoid hymenophores, are *not* included in this subfamily.) Subfam. *Gyrodontoideae*

D. Hymenophore depressed or subfree around the apex of the stipe, not arcuate-decurrent.

E. Spore print yellow. 1. *Gyroporus*

E. Spore print olive brown. 2. *Phaeogyroporus*

D. Hymenophore more or less arcuate-decurrent.

F. Veil present; cystidia rather distinct. 3. *Paragyrodon*

F. Veil none; cystidia usually very rare and inconspicuous. 4. *Gyrodon*

C. Clamp connections either not constant in a genus (*Boletinus*) or very sparse (not more than 1–10 clamps per 100 septa), or persistently lacking.

G. Hymenophore either boletinoid (lamellately arranged, radiately elongate pores, adnato-decurrent or deeply decurrent), or covered by a viscid-membranaceous or glutinous veil, or stipe with glandulae, or at least pileus (not stipe except, possibly, for the veil) strongly viscid (this latter character has to be combined with small, pale melleous, elongate spores, large, incrusted cystidia and cylindric or subcylindric stipe; — if not showing these additional characters, the species is *not* included in this subfamily). All species exclusively connected with coniferous trees by mycorrhiza (species forming mycorrhiza with frondose trees, or not forming mycorrhiza with Gymnospermae *only*, are *not* included in this subfamily). Subfam. *Suilloideae*

H. Veil none; stipe somewhat hollow; hymenophore more lamellately arranged near the margin than near the stipe; pileus not viscid. 5. *Psiloboletinus*

H. Veil present or absent; stipe hollow or solid; hymenophore, if arranged lamellately at all, more so toward the stipe than at the margin of the pileus; pileus viscid or dry; fungi not combining the characters indicated for *Psiloboletinus*.

I. Veil present; pileus dry, or rarely becoming viscid during its development, starting from the margin, fibrillose or scaly or floccose, these ornamentations or coverings being part of the cuticle proper, not the veil; stipe always without glandulae; hymenophore usually very strongly boletinoid, never composed of fine (diameter 0.5 mm. and less) pores; clamp connections present in many species. 6. *Boletinus*

I. Veil present or absent; if there is a veil, the pileus is never scaly or squamulose, or/and the hymenophore is composed of fine pores; pileus always viscid; glandulae frequently present on the stipe, and sometimes on the

[4] Use the mycelioid base of the stipe, or one of the cortical layers for examination. For further technical hints see Singer, Lloydia 5: 98. 1942.

pores; hymenophore boletinoid or not boletinoid; clamp-connections none. 7. *Suillus*

G. Hymenophore not boletinoid; veil, if present at all, either glutinous or pulverulent and then yellow (yellow-green, reddish-yellow) and dry; stipe without glandulae; pileus viscid or not; species forming mycorrhiza with conifers or frondose trees; or possibly not forming mycorrhiza.

K. Lateral stratum of the hymenophoral trama of the *Phylloporus*-type (its hyphae only slightly divergent, rather close, and only little paler, if at all so, than the mediostratum, often becoming irregular in age); hymenophore made up of lamellae, or of tubes, the tubes usually wide (about or above 1 mm. in diameter); spore print olive brown, never pinkish, nor ferruginous-ochraceous, nor avellaneous-ochraceous, nor cinnamon-isabelline. Subfam. *Xerocomoideae*

L. Hymenophore lamellate. 8. *Phylloporus*

L. Hymenophore tubulose. 9. *Xerocomus*

K. Trama truly bilateral-divergent (*Boletus*-type) when young, (lateral stratum loosely arranged, strongly divergent, much paler than the mediostratum, usually hyaline, but its hyphae becoming stretched from rapid longitudinal growth of the tubes shortly before full maturity, and then becoming parallel with the mediostratum); hymenophore always made up of tubes with either wide or small pores; spore print not always olive brown. Subfam. *Boletoideae*

M. Stipe *not* combining the following characters: tapering from the base or more rarely from the middle to a slender apex, of fibrous-hard context, with scabrous squamulae or furfuraceous dots which usually are darker than the remaining surface of the stipe, or becoming so in age; pores small or wide, red or concolorous, free or adnate; mycorrhiza with frondose trees or with coniferous trees, or possibly no mycorrhiza formed.

N. Spore print consistently brownish with an olivaceous tinge.

O. Veil present or absent; if the veil is present, it consists of a yellow (yellowish-green, reddish-yellow) pulverulence, or it is entirely glutinous; if the veil is absent, the stipe is viscid in fresh, young specimens, or the pileus is covered by a yellow pulverulence; rarely, in avelate forms, there is no pulverulence and the stipe is not viscid; in this case the cuticle of the pileus is viscid; in old or dried specimens the hymenophore often assumes a very deep golden yellow, or golden olive, or reddish orange color.

P. Hymenophore a thin to medium thick layer of decurrent tubes, arcuate at least when young; stipe frequently swollen ventricose and sometimes furrowed at the base where it is continued into a dense mycelial growth which often takes the shape of a

pseudomycelium; context frequently turning blue on exposure; veil none; size of the carpophores often remarkable. 10. *Phlebopus*

P. Hymenophore consisting of rather long tubes, not decurrent, either adnate or depressed around the stipe, either applanate or convex beneath; stipe usually not swollen-ventricose, mostly more or less cylindric, or slightly thickened downwards; pseudosclerotium none; context rarely turning blue on exposure, and, if it does, there is a yellow pulverulent veil present. 11. *Pulveroboletus*

O. Veil none; stipe not viscid; pileus not covered with yellow pulverulence; if the pileus is viscid, or the base of the stipe covered with abundant yellow mycelium, the cuticle is made up of a trichodermium-pallisade or epithelium. 12. *Boletus*

N. Spore print not showing a trace of an olivaceous tinge even if it is quite fresh.[5]

Q. Spore print rusty-yellow; spores bright golden under the microscope, long-cylindric, bacilliform, and narrow; stipe smooth and glabrous; context white, unchanging, mild. 13. *Xanthoconium*

Q. Spore print deeper ferruginous, or wood brown, or fawn color, or pinkish vinaceous, not golden under the microscope, not exactly cylindric in their majority, or rarely so; stipe rarely smooth and glabrous as well; context rarely white and unchanging, and mild as well. 14. *Tylopilus*

M. Stipe (though somewhat variable in shape) mostly tapering upwards from the base or more rarely from the middle, beset with darker (or becoming darker) furfuraceous or squamulose scabrosities, rather fibrous-hard in the larger lower part but tender-fleshy in the apex, the scabrosities consisting of dermatobasidia, dermatopseudoparaphyses, and dermatocystidia, forming a terminal hymenium on a fascicle of parallel hyphae; pores very small, never red; tubes long, especially in the middle between the stipe and the margin of the pileus, deeply depressed-free around the stipe; mycorrhiza almost constantly with trees of the orders Fagales and Salicales. 15. *Leccinum*

* * *

[5] The spore print should be examined immediately after a thick layer of spores on white paper — without the hymenophore of the specimen touching it — has been obtained, and the correct equivalent in Ridgway must be noted. Old spore prints change their color.

KEY FOR DETERMINATION OF THE GENERA OF BOLETACEAE OCCURRING IN FLORIDA

A. Clamp-connections present (choose this alternative even if they are very scarce).

B. Hymenophore depressed around the stipe; spore print yellow. 1. *Gyroporus*

B. Hymenophore decurrent; spore print brownish.

C. Hymenophore lamellate. 8. *Phylloporus*

C. Hymenophore tubulose. 4. *Gyrodon*

A. Clamp-connections none.

D. Veil present.

E. Veil yellow, pulverulent. 11. *Pulveroboletus*

E. Veil not yellow, and not pulverulent.

F. Veil viscid in wet weather; pores not radiately arranged (i.e. not boletinoid); pileus viscid when wet; stipe with glandulae, rarely without them (and then the veil mostly rudimentary, only marginal). 7. *Suillus*

F. Veil dry, even in wet weather; pores radiately arranged (boletinoid); pileus non-viscid; stipe without glandulae. 6. *Boletinus*

D. Veil none.

G. Hymenophore lamellate. 8. *Phylloporus*

G. Hymenophore tubulose.

H. Spore print brown with an olive tinge, or decidedly olive.

I. Cuticle of the pileus with a distinct epithelium, consisting of several layers of spherocysts which are usually arranged in erect chains, later becoming free, and eventually often washed off; hymenophore depressed around the stipe, pores small, yellow; stipe more or less furfuraceous or squamulose-scabrous. 15. *Leccinum*

I. Pileus without a distinct epithelium.

J. Stipe fibrous-fleshy and rather hard, gray to black squamulose-scabrous on white to pale grayish ground; context white, changing to sordid lilac on exposure. 15. *Leccinum*

J. Stipe not scabrous and usually soft-spongy-fleshy; context white or colored, changing or unchanging.

K. Pileus with a yellow pulverulence, *or* stipe with glandulae, *or* stipe viscid, *or* hymenophore arcuate-decurrent when young with the tubes rather short to barely medium long.

L. Glandulae present on the surface of the stipe; mycorrhiza with *Pinus*. 7. *Suillus*

L. Glandulae none.

M. Hymenophore arcuate-decurrent in young specimens shortly before full maturity, tubes rather short to barely medium long; spores small (5.5–11 x 2.7–4.8 μ); growing on pine trunks. 10. *Phlebopus*

M. Hymenophore arcuate-decurrent but in primordial stage; tubes medium to long in mature specimens; spores usually larger than indicated above; not or only accidentally growing on pine trunks. 11. *Pulveroboletus*

K. Pileus without yellow pulverulence in any stage; stipe neither beset with glandulae, nor viscid in any stage; hymenophore arcuate-decurrent but in primordial stage, tubes medium to long.

N. Pores wider than 1 mm. in diameter.

O. Pileus viscid and tomentose at the same time; carpophore small (pileus 10–20 mm.); spores small (6–9.3 x 2.8–4.2 μ); trama of the *Phylloporus*-type. 9. *Xerocomus*

O. Pileus rarely viscid and tomentose at the same time; carpophore mostly larger than 20 mm. broad; spores larger than 9.3 μ, or at least some of the spores of a print larger; trama of the *Phylloporus*-, or of the *Boletus*-type; fungi not combining the characters indicated above.

P. Surface of the pileus (if fresh and young) strongly reacting with NH_3 and NH_4OH, becoming vivid blue, to bright bluish green; trama of the *Phylloporus*-type. 9. *Xerocomus*

P. Surface of the pileus not reacting as indicated above; trama of the tubes of the *Boletus*-type.

Q. Pores vivid golden yellow, remaining so on drying; stipe not very thick, subglabrous and smooth; context unchanging; pileus viscid when wet. 11. *Pulveroboletus*

Q. Not combining the above characters. 12. *Boletus*

N. Pores decidedly smaller than 1 mm. (if in doubt, or if pores around 1 mm. wide, see "O"). 12. *Boletus*
(but compare *Pulveroboletus retipes*)

H. Spore print without an olivaceous tinge ("Isabella color," some kind of vinaceous pink to wood brown, fawn color, etc., or a rusty brownish yellow).

R. Spore print rusty brownish yellow; spores under the microscope bright and intensely golden yellow; context combining white (unchanging) color and mild taste; stipe combining smooth and glabrous surface; pileus not viscid, not scrobiculate. 13. *Xanthoconium*

R. Spore print not rusty brownish yellow, at least not when fresh; spores under the microscope brownish melleous, yellowish melleous, pale melleous or subhyaline to hyaline; context not combining white (unchanging) color and mild taste unless the pileus is viscid or scrobiculate; stipe not combining smooth and glabrous surface unless the pileus is viscid or scrobiculate.

S. Stipe with distinct or indistinct glandulae, usually cylindric and not very thick, rarely swollen; mycorrhiza with pines; spore print "ochraceous tawny" to "Isabella color"; hymenophore adnate-decurrent; pileus glutinous. 7. *Suillus*

S. Stipe always completely devoid of glandulae (lens), usually cylindric and then very thick, or thickened at some part; mycorrhiza with pines or with other trees, never exclusively with pines; spore print not "Isabella color" (the nearest it may occasionally come to "Isabella color" is "colonial buff"); pileus viscid or dry. 14. *Tylopilus*

Subfam. **Gyrodontoideae** Sing. subfam. nov.

Hyphis constanter fibuligeris; sporis ellipsoideis vel globosis, brunneolis vel flavis.

Characters of the subfamily: see key (p. 226) and Latin diagnosis. The type genus is *Gyrodon* Opat.

The genera *Gyrodon*, *Paragyrodon* (tribus Gyrodonteae Sing.) on one hand, and *Gyroporus* (tribus Leucoporelleae (Gilbert) Sing.) on the other hand did not seem to be easily combined into one subfamily or tribe, notwithstanding their obvious similarities, that is not until the tropical genus

Phaeogyroporus was discovered. The latter represents a perfect connecting link between the two former tribes Gyrodonteae and Leucoporelleae which now become superfluous.

1. **Gyroporus** Quél., Enchir., p. 161. 1886, *emend.* Pat., Ess. tax., p. 124. 1900.
   Suillus Karst., Bidr. Finl. Nat. Folk **37**:v. 1882, *non* S. F. Gray (1821).
   Coelopus Bat., Bolets, p. 12. 1908.
   Leucobolites G. Beck, Zeitschr. Pilzk. **2**:146. 1923.
   Leucoconius (Reichenb.) G. Beck, Zeitschr. Pilzk. **2**:146. 1923.

Characters of the genus: Pileus non-viscid, glabrous to coarsely fibrous-subsquamose; cuticle made up of repent or subascendant elongate but sometimes rather short and thick hyphae with thin or thick walls; hymenophore tubulose with concolorous, small to more often medium to large pores, depressed around the stipe, rather long, white, pink, or pallid-stramineous; spore print yellow; spores stramineous-subhyaline to yellow, ellipsoid, rarely more elongate than twice as long as broad, of medium size but rather variable in this regard; cystidia present; trama of the hymenophore-walls truly bilateral; stipe hollow or solid, its surface glabrous or fibrous, not reticulate; context white or whitish, unchanging, or becoming bright blue on exposure; hyphae (except for rare parthenogenetic aberrations) constantly with clamp connections; the usual inorganic reagents causing very slight or no color reactions; said to contain no boletol. Growing on the ground in temperate as well as in tropical regions, possibly occasionally forming mycorrhiza but sometimes fruiting without mycorrhizal connections. The type species is *Gyroporus cyanescens* (Bull. *ex* Fr.) Quél. This is also the type species of the genus *Leucoconius* Beck, and it is assumed that the logical type species of *Suillus* Karst. is the same species. The genus *Leucobolites* Beck is obviously framed around the characters of *Gyroporus castaneus*, the first species cited, and since this belongs in *Gyroporus*, all three genera are synonyms of *Gyroporus*. In the original sense of Quélet, *Gyroporus* contained several species which are now excluded from this genus, but Patouillard's emendation leaves no doubt about the sense in which *Gyroporus* has to be restricted. The genus *Gyroporus* has been almost unanimously accepted by mycologists at present though it usually is incorrectly (spore print "white") or insufficiently (no mention of clamps) characterized.

KEY TO THE SPECIES

A. Pileus white, whitish cream color, stramineous, greenish, clay color, pinkish or umber.
   B. Context unchanging on exposure.
      C. Pileus "tawny olive," "Isabella color," "Saccardo's umber" when fresh, strongly and coarsely fibrous and usually subsquamose, assuming a characteristic green color on drying if the specimens have been old, watersoaked and exposed for several hours before drying.
         2. *G. umbrinisquamosus*

C. Pileus not as dusky colored as above, more white to pale stramineous, or pinkish, less strongly fibrous to completely glabrous, not assuming a green color on drying. 1. *G. subalbellus*

B. Context strongly bluing on exposure. 3. *G. cyanescens*

A. Pileus fulvous, fulvous-ferruginous, castaneous-fulvous, tawny, cinnamon to whitish cinnamon, or deep red, purplish carmine, or deep purplish violet.

D. Pileus deep purplish violet. *G. atroviolaceus*

D. Pileus not colored as above.

E. Pileus deep red, purplish carmine. 4. *G. purpurinus*

E. Pileus not colored as above. 5. *G. castaneus*

1. **Gyroporus subalbellus** Murr., N. Am. Fl. **9**:134. 1910.
Suillus subalbellus Sacc. & Trott., Syll. **21**:252. 1912.
Gyroporus roseialbus Murr., Mycologia **30**:520. 1938.

Pileus with a basic white color but sometimes flushed with "sea shell pink," or "apricot buff," the disc often "cinnamon buff," and besides frequently with cinnamon or pale cinnamon dots, rarely pale yellow instead of white, frequently partly or entirely covered with a coarse but thin "colonial buff" fibrillosity reminiscent of *G. cyanescens* and then parts of the pileus or the entire surface shaded with this color, the disc, if fibrillose, even reaching "chamois," the glabrous surface sometimes minutely tessellate, not viscid, the margin sterile and then incurved when young, or fertile, convex, frequently with more or less depressed center, (25)–35–100 mm. — *Hymenophore* white or whitish, becoming "cream color" to "mustard yellow" with age, about 4 mm. deep, depressed or rarely adnate to the stipe, unchanging on injury; tubes rather long, (3)–5–8 mm. long; pores concolorous, rather small (2.5 per mm.) to medium wide (0.9 per mm.); spore print "colonial buff" with a hue of "straw yellow." — *Stipe* white or somewhat concolorous with the pileus, very frequently flushed with pink, "sea shell pink," "shell pink," "buff pink," "light salmon orange," frequently stained with "cinnamon buff" like the pileus, or with brownish, olivaceous or umbrinous spots near the base, the apex usually more white than the rest of the stipe, glabrous or somewhat furfuraceous to slightly tomentose-fibrillose, smooth, equal, or with enlarged base, rather frequently swollen and distorted, solid, becoming stuffed and finally with cavities or hollow, (25)–33–80 x (6)–11–30 mm. — *Context* white, sometimes salmoneous in the cortex of the stipe, absolutely unchanging; odor none, or agreeable, reminding one of cinnamon; taste mild.

Spores 7.5–13.8 x 4–5.5–(6) μ, short-cylindric-ellipsoid, ellipsoid, or ovoid, hyaline with a slight or bright yellowish tint, with suprahilar depression or applanation, smooth; *basidia* 28–33 x 8–11.5 μ, 4-spored; *cystidia* versiform, mostly fusoid; trama of the tube-walls truly bilateral as in *G. castaneus*; *fibrillosity of the pileus* and the stipe of strands of parallel hyphae, or of irregularly interwoven hyphae with often thick, yellowish walls, occasionally rather short members between septa, 3–18 μ thick, the terminal ones usually clavate, more rarely subulate and more or less acumi-

nate; all *hyphae* with clamp connections, or at least a large percentage of them with clamp connections, in some rare depauperate forms all hyphae clampless.

Chemical reactions: **KOH** negative (faintly sordid). — **NH_4OH** and **NH_3** negative. — **HNO_3** negative (faintly yellowish). — **$FeSO_4$** faintly grayish-pallid, stuffing of old stipes pale green (weak reaction). — **Methylparamidophenol** in the fibrillose form in Highlands County negative, in the glabrous form in Alachua County distinctly and quickly positive (deep violet). — **Phenol** very slowly becoming more or less deeply chocolate. — **Formol** negative or almost so (rarely very pale grayish red). — **Aniline** negative.

Habitat: Under oaks, and under pines in mixed and pure stands, on lime rock, gravel and sandy soil, outside the woods and in dense high, mesophytic and tropical hammocks, solitary, or more commonly in groups, fruiting from May to October.

Distribution: From North Carolina to Florida and west to Mississippi. In Florida common in all zones.

Material studied: **Fla.** Alachua Co., Gainesville, under oaks, August 1937, **type** of *G. roseialbus* (FLAS); also **co-type** and **authentic** material (FH), *F 9292* (FLAS); *F 19576* (FLAS); in and near Gainesville, *R. Singer, F 2560a* (FH); *F 2021* (FH); *F 2105* (FH); *F 2147* and *2147a* (FH); Sugarfoot Hammock, under oak, *R. Singer, F 2570* (FH); Newnan's Lake, Sept. 1941, under scrub oak, *G. Weber*, (det. Murrill) *F 18577* (this is a *forma depauperatus*) (FLAS); Highlands Co., Highlands Hammock State Park, sandy roadside under *Pinus palustris*, August 1942, *R. Singer, F 389* (FH); Marion Co. near Altoona, October 1941, *W. A. Murrill, F 21541* (FLAS); Dade Co., Matheson Hammock, *R. Singer, F 707* and *F 707 a* (FH); Brickell's Hammock, *R. Singer, F 1071* (FH).[6] — **Miss., type** of *G. subalbellus* (N.Y.)

Murrill says that his *G. roseialbus* differs from *G. subalbellus* "in its rosy tints, glabrous surface, and solid stipe." I did not find these characters correlated in any way. The type of *G. subalbellus* is partly fibrillose, but I have found more distinctly fibrillose specimens with pink stipe, and perfectly glabrous specimens without a suggestion of pink. The solid stipe later becomes hollow, a phenomenon that can be observed at varying stages of development exactly as in *G. castaneus*. My number *F 2570* has slightly furfuraceous pileus and is consequently intermediate between the glabrous and the fibrous form. Somebody may yet find it worth his while to erect formae for all these variations and combinations of unimportant characters. At present, I think we can do without them. The only character that gives some weight to the distinction between glabrous and fibrous forms is the reaction with methylparamidophenol; further tests will probably show that the reaction is variable in both forms.

[6] There is also an indication of this species from Seminole Co., Altamonte Springs (*fide* Beardslee).

Coker and Beers (Boletaceae, p. 14. 1943) mention a *"form with unchanging flesh"* of *G. cyanescens*. There is no doubt but that this is *G. subalbellus*.

Murrell's number *F 18577* is interesting because it represents an example of a depauperate (much smaller in all its parts), probably parthenogenetic form without clamp connections; the spores are normal, and the basidia 4-spored as usual. It belongs to the glabrous form. Murrill's co-types of *G. roseialbus* (*F 9887* and *F 9288*) are not cited here because they belong, at least partly, to *Xanthoconium stramineum*. The latter species and *G. subalbellus* are sometimes macroscopically similar but the shape of the spores, their color both under the microscope and in print, and, as a rule, the presence or absence of clamp connections help to identify them.

G. subalbellus, like other species of this genus, does not seem to show any preference for specific forest trees. I have found it growing exclusively under *Pinus australis* at one locality, under *Pinus palustris* at another, and many times under various species of *Quercus* without any conifers nearby.

2. **Gyroporus umbrinisquamosus** Murr., Bull. Torr. Bot. Club, **66**:33. 1939.

Pileus "tawny-olive," "Isabella color," "Saccardo's olive," strongly fibrous-tomentose-subsquamulose all over, more so on the margin, not viscid, convex, 55–75 mm. broad. — *Hymenophore* whitish becoming yellowish, deeply depressed around the stipe, tubes moderately long (about 6 mm.), pores concolorous, small (about 2.5 per mm.), spore print as in the preceding species. — *Stipe* concolorous with the pileus and covered with the same felt, more so toward the base, solid, soon becoming hollow, enlarged below, 50–85 x 12–25 mm. — *Context* white, unchanging; odor none, taste mild.

Spores 9.5–16 x 4.5–7.5 μ, ellipsoid to rarely somewhat allantoid, with a suprahilar applanation or depression, smooth, yellowish-hyaline; *basidia* 25–28 x 9–14 μ, 4-spored; *cystidia* 35–38 x 6.3–10 μ, numerous, especially near the pores, hyaline, more or less fusoid, the thickest part in the middle or nearer the apex which is rounded or acute; trama not studied; the *fibrous coating* of the pileus and the stipe consisting of strands of parallel, cylindric, greenish-melleous hyphae, with slightly thickened walls, the terminal members cylindric, fusoid, or clavate, 7–15 μ thick; *hyphae* with clamp connections.

Chemical reactions: Watersoaked, old material turns a characteristic green when dried slowly, this green color disappears later in the herbarium; reactives tested gave the same results as obtained with *G. subalbellus*.

Habitat: In turkey oak woods (*Quercus Catesbaea*) and in high hammocks (with *Quercus laurifolia* and *Q. virginiana*), on sandy, humous soil, fruiting from July until October. Solitary and rare.

Distribution: Known only from Alachua Co., Florida, U.S.A.

Material studied: **Fla.** Gainesville, Sept. 1938, **type** (FLAS); July 1943, *R. Singer, F 2776* (FH); West of Micanopy, Oct. 1939, *W. A. Murrill* (FLAS); Newnan's Lake, July 1943, *R. Singer, F 2911* (FH).

This species is very closely related to *G. subalbellus*, and though the

color change of dried specimens which I have never observed in the latter species, as well as possibly the higher upper limit of the spore measurements, would seem to favor its distinction as a separate species, I have hesitated a long time to admit it as such. One of W. A. Murrill's collections (*F 18461*) looks exactly like *G. umbrinisquamosus* in dried condition, and at the same time, the color of the pileus was indicated as pale yellow, and it was determined by Murrill as *G. roseialbus*. One may be inclined to consider this as a transitional form, yet it is possible that a line between this latter form and the typical *G. umbrinisquamosus* will prove to be constant enough to maintain the latter as an autonomous species.

3. **Gyroporus cyanescens** (Bull. *ex* Fr.) Quél., Enchir., p. 161. 1886.
Boletus cyanescens Bull. *ex* Fr., Syst. Mycol. **1**:395. 1821.
Leccinum constrictum (Pers. *ex*) S. F. Gray, Nat. Arr. Brit. Pl. **1**:647. 1821.
Boletus lacteus Lév., Ann. Sci. Nat. sér. III **9**:124, *pl. 9, fig. 1–2*. 1848.
Suillus cyanescens Poir. *in* Lam. *ex* Karst., Bidr. Finl. Nat. Folk **37**:1. 1882.
Gyroporus lacteus Quél., Enchir., p. 161. 1886.
Gyroporus cyanescens var. *lacteus* Quél., Fl. Mycol., p. 425. 1888.

Pileus stramineous-yellowish, subalutaceous, sordid or pale sulphureous, pale straw color, greenish yellow, or nearly whitish pallid, eventually often becoming a pale brownish umber, covered with a coarse fibrous felt, not viscid, pulvinate, usually becoming subplane or irregular, 35–120 mm. broad. — *Hymenophore* white, then yellowish, bluing on injury, depressed around the stipe, often almost free, tubes rather long (2.5–8 mm.), pores concolorous, irregularly polygonal or subcircular, moderately wide; spore print between "colonial buff" and "straw yellow." — *Stipe* cremeous-sordid, yellow, or otherwise similar to the pileus in color, paler (to white), or grayish white at the apex, rarely subglabrous, mostly covered with the same kind of felt as the pileus, smooth, solid or stuffed, then with several small cavities, or hollow, tapering upward, more rarely subequal, 30–120 x 10–30 mm. — *Context* of pileus white, strongly turning cyaneous (the blue of bachelor's buttons) when wounded, sometimes somewhat reddish brown in the base of the stipe and palest yellow–stramineous in the rest of the stipe, becoming greenish blue on injury; odor none; taste mild.

Spores 8–16 x 4–8 μ, ellipsoid to ovoid, most frequently 10–11 x 5–6 μ, smooth, stramineous-subhyaline; *basidia* 25–40 x 8.5–12 μ; *cystidia* 35–52 x 8–10.5 μ, cylindric-clavate, or cylindric-fusoid; *trama* truly bilateral; *fibrosity* of the pileus consisting of (5)–9–20–(25) μ thick, cylindric, stiff, yellowish hyphae, the thin ones lemon yellow, most septa with clamp connections.

Habitat: In woods and even on meadows of all kinds, most frequent on sandy soil and on sandy loam, also on clay soil; fruiting from July until November.

Distribution: Europe, Caucasus, North America. In Florida very rare, only in the northern part.

Material studied: **Fla.** Alachua Co., Gainesville, on the ground under pines, *W. A. Murrill* (FLAS). — **Canada,** N.B., July 1902, *W. G. Farlow*

(FH). — **N.H.,** White Mts., Crystal Cascade, on ground near stump, Sept. 1891, *W. G. Farlow* (FH); Chocorua, Aug. 1904, *W. G. Farlow* (FH). — **Mass.** Newton, Sept. 1892, *W. G. Farlow* (FH); Waverley, Aug. 1897, *W. G. Farlow* (FH); Magnolia 1907, *E. B. Blackford* (FH). — **N.Y.** Ebor, Nov., *C. H. Peck*, (as *Boletus variegatus*) (*217*) (NYS). — **Tenn.** Great Smoky Mts., Chimney Trail, birch woods, Aug. 1939, *D. H. Linder* (det. Snell) (FH); Greenbrier, *A. J. Sharp* (det. L. R. Hesler) (FH). — Numerous fresh collections and specimens in European herbaria. — **Caucasus,** Abkhazia, Saken R., under roots of *Fagus orientalis* Aug. 1929, *R. Singer* (W); Malaya Laba R., Aug. 1935, *L. N. Vasilieva* (KAZ).

This species cannot be distinguished with certainty from the two preceding species unless studied in fresh condition. I have to rely on W. A. Murrill's determination of the fresh material as far as the occurrence of this species in Florida is concerned. *G. cyanescens* is edible. It does not seem regularly to form mycorrhiza, at least no preference of any forest tree is shown, and sometimes fruiting bodies are formed far from any tree at all. The above description has been filed from notes on European and Caucasian collections of this author, except for the characterization of the trama which resulted from New England material, and strongly disagrees with the findings of Elrod and Blanchard who found it decidedly not bilateral. I can only repeat that it is essential to study young stages, just when the hymenium begins to sporulate, in order to be sure that comparable material of the species examined is at hand. If this is done, there is not the slightest difference in the structure of the trama of the various species of *Gyroporus*.

4. **Gyroporus purpurinus** (Snell) Sing. comb. nov.

Boletus castaneus f. purpurinus Snell, Mycologia **28**(5):465. 1936.

PLATE I, FIG. 1–4.

Pileus "neutral red," "mineral red," almost "bordeaux," or "garnet brown" and "maroon," or "deep vinaceous," velutinous or punctate-subtomentose, then somewhat furfuraceous, pulvinate-convex, then plano-convex, often with more or less depressed center, with obtuse margin, not viscid, 11–50 mm. broad. — *Hymenophore* white, eventually becoming "naphthalene yellow," adnate-subdepressed, becoming deeply depressed around the stipe, convex beneath, pores small, then wide (1 to 3 per mm.), concolorous; spore print between "amber yellow" and "citron yellow," *i.e.* brighter yellow than in the *G. cyanescens* group. — *Stipe* concolorous with the pileus and occasionally slightly inclining to brownish, apex frequently white, entirely velutinous-subfurfuraceous, stuffed and with cavities, or plainly hollow, equal or tapering upward, 30–40 x 2.5–8 mm. — *Context* pure white, unchanging; odor none; taste mild.

Spores 8.2–11.5 x 5.5–6.8 μ; *basidia* 21–27 x 11.5–12.2 μ, 4-spored; *cystidia* at the pore mouths characteristically narrowly subulate, the apex acuminate-obtusate or subacute, hyaline, thin-walled, numerous, 23–43 x 3.3–4.7 μ; *trama* of the tube walls truly bilateral, the mediostratum scarcely

hyaline; *cuticle* consisting of irregularly arranged, unequal hyphae, the terminal members of which are mostly erect to form (with 1–2 of their basal hyphae) a trichodermium-palisade, the terminal members cystidioid, subulate, ampullaceous or fusoid, rarely vesiculose, 40–100 x 5.3–20 μ, thin- or moderately thick-walled, filled with a purple cell-sap; a similar covering on the stipe; *hyphae* with clamp-connections, but the clamps may be rather scattered.

Chemical reactions: **NH_3, NH_4OH, KOH** and **aniline-oil** on cuticle and on context almost negative.

Habitat: Shaded places under various trees, in tropical and low hammocks, and also in forest of a more northern type outside of Florida, in general growing under the same conditions as *G. castaneus*, but never as far from forest trees as the latter. Solitary to gregarious, fruiting from July until October.

Distribution: North America from New York to Florida, and west to Michigan. In Florida widely distributed, moderately frequent in all zones.

Material studied: **Fla.** Dade Co. Matheson Hammock, Sept.–Oct. 1942, under *Bursera, Ficus, Nectandra, Quercus, R. Singer, F 878, F 1174* (FH); Oct. 1942, under *Pinus caribaea, Casuarina spec., Quercus virginiana, R. Singer, F 1174 a* (FH); Alachua Co., Gainesville, July 1943, under *Liquidambar, Ostrya, Carpinus, Prunus, Quercus* spec., *R. Singer, F 2623* (FH); Planera Hammock, July 1943, *R. Singer, F 2885* (FH); July 1938, *W. A. Murrill & Erdman West, F 7917* (FLAS).

G. purpurinus is, in the author's opinion, not a form or variety of *G. castaneus* but a good species. Aside from the constant and persistent difference in color, this species is of slightly smaller average size than *G. castaneus*, and its surfaces have a much more pronounced tendency to become furfuraceous than in the latter species. This is by no means a color variant within the ordinary variation of *G. castaneus* since it is absent in parts of the north and west of the United States and in Europe, and it is also not a geographic race because it grows together with *G. castaneus* in some states of this country. This most beautiful species of the Gyrodontoideae has first been validly described by W. H. Snell but it has also been collected by W. A. Murrill who filed it under an unpublished varietal name.

5. **Gyroporus castaneus** (Bull. *ex* Fr.) Quél., Enchir., p. 161. 1886.
   Boletus castaneus Bull. *ex* Fr., Syst. Mycol. **1**:392. 1821.
   Boletus cyanescens B *fulvidus* Fr., Syst. Mycol. **1**:395. 1821.
   Boletus fulvidus Fr. *ex* Fr., Epicr., p. 426. 1838.
   Boletus testaceus Pers., Mycol. Eur., **2**:137. 1825.
   Suillus castaneus Poir. *in* Lam. *ex* Karst., Bidr. Finl. Nat. Folk **37**:1. 1882.
   Gyroporus castaneus var. *fulvidus* Quél., Enchir., p. 161. 1886.
   Boletus rufocastaneus Ell. & Ev., N. Am. Fungi, 2nd ser., no. 2302. 1890, *nomen nudum.*

Pileus "cinnamon rufous" to "Kaiser brown," or "tawny" to "hazel," or "Sanford's brown" to "xanthine orange," or "pecan brown" to "Rood's brown," rarely paler ("cinnamon buff," "pinkish buff," or even "pale pink-

ish buff"), usually lighter colored on the margin, pubescent-subvelutinous to finely tomentose, rarely subglabrous, not viscid, convex, then irregularly applanate, or with depressed center, or rarely entirely concave, (20)–30–80 mm. broad. — *Hymenophore* white or whitish at first, then becoming cream color to light yellow or light lemon yellow from the spores, sometimes staining brown on injury, depressed around the stipe, or becoming so, tubes up to 8 mm. long; pores small to medium (1–3 per mm.); spore print as in *G. purpurinus*. — *Stipe* concolorous with the pileus, the apex usually paler, slightly tomentose-subvelutinous, not viscid, sometimes irregularly furrowed, tapering upward, more rarely subcylindric, solid, then stuffed, and eventually hollow, the hollow stage beginning at different stages depending on the individual, rarely stuffed even when quite old, 35–80 x 8–22 mm. — *Context* white or whitish and unchanging on exposure, the cortical layer of the stipe and sometimes under the cuticle of the stipe concolorous with the surface, firm and fleshy, later soft and brittle; odor none; taste mild.

Spores 7–11 x 4.5–6 μ, ellipsoid with suprahilar applanation, stramineous-hyaline to stramineous, smooth, many of them with an ellipsoid to subglobose central oil-drop, with thin to rather thick, simple wall, non-amyloid; *basidia* 27–40 x 8–11.2 μ, 4-spored; *cystidia* on the pore mouths subulate, gradually tapering from the 4–6 μ thick base toward the acuminate but rarely acute apex, 20–55 μ long, thin-walled, hyaline, numerous; on the side of the tube walls the cystidia are scattered, more or less fusoid, 38–46 x 7–11 μ; *cuticle* of the pileus and the stipe consisting of rows of filamentous hyphae which are rarely shortened and irregularly vesiculose, their diameter 5–17.5 μ, their septa with clamp connections (some clampless), with rather thick wall, with fulvous, yellow, or hyaline cell-sap, terminal hyphae often upright with rounded apex; *trama* of the hymenophore truly bilateral with distinctly divergent, looser lateral stratum in young specimens; the majority of the thin-walled hyphae with clamp connections.

Chemical reactions: **KOH** and **NH_4OH** very slight or no reaction; **methylparamidophenol** positive on context of very fresh material, reaching "vinaceous-purple," in less fresh material merely staining brown; **phenol** chocolate.

Habitat: In mixed forests, coniferous woods, frondose woods, open places, low hammocks, mesophytic hammocks, and high hammocks, on lawns under oaks, on fields and pastures, on various kinds of soil, however rare or wanting on strongly calcareous soil, very rarely on very decayed wood, fruiting from May till October.

Distribution: With certainty known from Europe and North Africa, and, what appears to be the same species, in temperate North America, common in both dry-warm and damp-warm climates, also indicated in Australia but unconfirmed from there; in Florida common but not reaching the tropical zone.

Material studied: **Fla.** Alachua Co. Gainesville, det. W. A. Murrill (FLAS); *R. Singer, F 2754* (FH); *F 2145* (FH); *F 2145a* (FH); Highlands Co., Highlands Hammock State Park, *R. Singer, F 51, F 51 a, F 51 b*

(FH). — **N.H.** Shelburne, *W. G. Farlow* (FH). — **Mass.:** Bedford, *W. G. Farlow* (FH); Cambridge, *W. G. Farlow* (FH); *R. Singer* (FH); *G. D. Darker* (FH); Jamaica Plain, *G. D. Darker, 5223* (FH); *6141* (FH); *6153* (FH); Wellesley, *D. H. Linder* (FH); Newton, *W. G. Farlow* (FH); *G. D. Darker, 5364* (FH); Canton, July 1933, *D. H. Linder* (FH); Aug. 1933, *id.* (FH); Purgatory swamp, *D. H. Linder & R. Singer* (FH); Wakefield, *D. H. Linder & R. Singer* (FH); Nantucket Co., *E. V. Seeler, 108* (FH). — **N.J.** Newfield, 1886, *Ellis,* Herb. Farlow *ex* Herb. Ellis (*B. rufocastaneus* Ell., **authentic**) (FH); 1891 (FH); Ellis and Everhart, N. Am. Fungi, l.c. (**type** of *B. rufocastaneus*) (FH). — **Spain,** Catalonia, Aiguamoix Valley, Aug. 28, 1934, *R. Singer* (BA), and numerous collections of fresh material from France to the Caucasus; also abundant material in various herbaria.

EXTRALIMITAL SPECIES

Gyroporus atroviolaceus (Hoehn.) Gilbert, Bolets, p. 102. 1931.

Suillus atroviolaceus Hoehn., Sitz.-ber. Akad. Wiss. Wien **123**:87; Fragm. 16 (834):39. 1914.

This species has been described from Java. The type (FH) shows ellipsoid hyaline-citrinous spores with a slight suprahilar depression, or applanation, 8.8–9.5 x 6.3–6.7 μ; basidia 26.5–31.5 x 12–14 μ, 4-spored; cystidia fusoid, brownish, 41–75 x 7–16 μ; cuticle consisting of elongate hyphae with cylindric, clavate, or broadly fusoid terminal members, the apices of which are frequently thickened, 25–90 x 9.5–21 μ, many septa with clamp connections; they are now brown, but Hoehnel, on fresher material, found them violet, and up to 140 x 25 μ.

SPECIES INCOMPLETELY KNOWN

Gyroporus Earlei Murr., Mycologia **13**:60. 1921.

Boletus Earlei Overh. *in* Seaver & Chardon, Sci. Surv. Porto Rico **8**:156. 1926.

This species, described from the West Indies, is preserved but not in a condition that would permit any conclusions.

Gyroporus caespitosus Clel., Toadst. & Mushr. **2**:186. 1935.

This species, described from South Australia, cannot be considered as certainly belonging in this genus as long as no specimens are available.

SPECIES EXCLUDENDAE

Gyroporus rufus (Schaeff. *ex*) Quél. belongs in *Leccinum.*

Gyroporus scaber (Bull. *ex* Fr.) Quél. belongs in *Leccinum.*

Gyroporus porphyrosporus (Fr.) Quél. is *Porphyrellus pseudoscaber* (Secr.) Sing.

Gyroporus asprellus (Fr.) Quél. is a doubtful species, hardly a *Gyroporus.*

Gyroporus deflexus Murr. (*Leucogyroporus deflexus* Snell) is a young stage of some bolete but most certainly not a *Gyroporus.*

Gyroporus praeanisatus Murr. belongs in *Tylopilus*.
Gyroporus pisciodorus Murr. is *Tylopilus tabacinus* (Peck) Sing.
Gyroporus fumosiceps Murr. is *Boletus fumosiceps* Murr.
Gyroporus Rhoadsiae Murr. is *Tylopilus Rhoadsiae* (Murr.) Sing.
Gyroporus stramineus Murr. is *Xanthoconium stramineum* (Murr.) Sing.

Gyroporus jamaicensis Murr. (*Suillus jamaicensis* Sacc. & Trott.)

This species, described from the West Indies, shows some interesting characters. The spores of the type (NY) are ellipsoid, smooth, non-amyloid, about twice as long as broad, with suprahilar depression or applanation, thin-walled, subhyaline, with hyaline walls and faintly yellowish contents, asymmetric, 9.5–11 x (4)–4.8–5.2 μ; basidia 20–25 x 10–12 μ; there are some hyaline cystidia with swollen base and ampullaceous apical neck, 20–30 x 11–12 μ, the neck *e.g.* 10 x 2.5–3 μ; trama of the hymenophore decidedly truly bilateral with a melleous, denser, more parallel-subinterwoven axillar mediostratum and a loosely arranged, strongly gelatinized hyaline lateral stratum with distinctly divergent hyphae; all septa are clampless; cuticle of the pileus consisting of hyphae which are little more than 1 μ thick but toward the surface become broadened up to 12 μ in diameter, and clavate; some clavate bodies of 6–8 μ diameter were observed at the apex of the stipe. As long as nothing is known about the variabilities of the characters and the exact color of the spore print and the chemical reactions, I hesitate to transfer this species to any other genus. However, it is obvious that this is not a *Gyroporus*, and my guess is that it belongs in *Tylopilus*.

Gyroporus albisulphureus Murr., Lloydia **7**:325. 1944.

I have seen only a small fragment of this species, and cannot say what it is. If it is not an abnormally colored form of some known species, it will probably be sought for among *Pulveroboletus* (if viscid) or *Boletus* where it would stand out because of its milk-white pileus. The microscopical characters which I could ascertain did not bear out the opinion of Murrill, who links it with *Gyroporus*. The spores are too elongate, not right in color, and the hyphae are without clamp connections.

Gyroporus bisporus Murr., l.c.

A small fragment of this species (FH), kindly sent me by its author, is insufficient to dispose of it. However, it can be said with certainty that it is not a *Gyroporus*.

2. **Phaeogyroporus** Sing., Mycologia **36**:360. 1944.

Characters of the genus: see key, p. 226, and the original description, *l.c.* The type species is *Phaeogyroporus Braunii* (Bres.) Sing. There are no representatives of this genus known to occur in Florida. However, in view of the taxonomic importance of this genus, and the possibility that at least one of its species may yet be discovered in the state, we add the descriptions of two extralimital species.

Phaeogyroporus Braunii (Bres.) Sing., Mycologia **36**:360. 1944.
Boletus Braunii Bres., Bull. Soc. Myc. Fr. **6**: XXXVII. 1890.
Suillus Braunii Kuntze, Rev. Gen. Plant. 3^2:535. 1898.

Pileus olive becoming dirty brown, smooth, glabrous, convex, becoming partly concave, 80–150 mm. broad. — *Hymenophore* yellow, turning brown, attenuate-adnexed or emarginate-depressed around the tubes, applanate beneath, but concave near the margin, not decurrent except in youth, tubes 8–11 mm. long, pores small (about 2 to a mm.); spore print olive brown. — *Stipe* yellow turning dirty brown, subglabrous, smooth, solid, tapering upward or downward, or thinnest in the middle, 55–63–(100, according to Bresadola) x 20–42 mm.; mycelium dingy melleous. — *Context* cream color in both pileus and stipe, moderately juicy, firm in the stipe; odor and taste not recorded, probably not distinctive.

Spores 7–8 x 5.3–6.3 μ, mostly 8 x 6 μ, smooth, pale brown, ellipsoid; *basidia* 21–25 x 9–9.5 μ; *cystidia* 40–50 x 6–18.5 μ, vesiculose, claviform, or subfusoid; *trama* of the hymenophore consisting of 3.5–9 μ thick, often somewhat wavy-subinterwoven (in mature material) hyphae, and some laticiferous vessels of about 4 μ diameter; *hyphae of the cuticle* of the pileus somewhat interwoven, with up to 7.7 μ thick terminal hyphae which are clavate, hyaline, and usually thick-walled (about 1 μ thick), with numerous large clamp connections.

Habitat: Solitary on the ground, fruiting during the early rains.

Distribution: Tropical West Africa, Camerouns to Liberia.

Material studied: **Liberia,** Ganta, April 1939, *G. W. Harley* (det. Singer) *40* (FH).

I have not seen the type collection. However, the few insignificant discrepancies between Bresadola's description and our own, which is entirely drawn from Liberian material, do not seem to indicate that there is a chance of a mistake. The spores are considerably smaller in Bresadola's diagnosis but young spores in our specimens are 5 x 4 μ. The smaller size of Bresadola's specimens and the shorter, subdecurrent tubes clearly indicate that the type was a rather young specimen, probably immature. Therefore Bresadola did not find basidia. What he thought were basidia, are probably cystidia according to the measurements given. *Boletus sudanicus* Har. & Pat. seems to be close to this species, possibly identical; cf. Heim, R. Rev. de Mycol. **1**:13. 1936.

Phaeogyroporus tropicus (Rick *apud* Rehm & Rick) Sing., Mycologia **36**:360. 1944.
Boletus tropicus Rick *apud* Rehm & Rick, Broteria **5**:223. 1905.

Pileus yellowish brown, velutinous to minutely subtomentose-squamulose, sometimes areolate, usually smooth, semiglobose, later depressed in the center and more or less wavy at the margin, 30–100 mm. broad. — *Hymenophore* ochraceous, then with an olivaceous tinge, the lower surface not or not much concave under the margin of the pileus, the rest applanate to convex and deeply emarginate around the stipe. — *Stipe* brownish yellow,

smooth, glabrous, solid, cylindric, or tapering downwards or upwards, 25–40 x 8–24 mm. — *Context* whitish; taste and odor not recorded.

Spores (6.3)–6.8–9.5–(11) x (4.9)–5.3–6.8 μ, short-ellipsoid, smooth, light brown, without suprahilar depression; *basidia* 9.3 μ broad, 4-spored; *cystidia* not seen but probably present; *cuticular tomentum* consisting of rich-melleous to golden-melleous, unequal or cylindrical, filamentous, often waved and nodose hyphae which often look like laticiferous vessels, 2.8–12 μ in diameter, scarcely intermixed with much thinner and less opaque hyphae; most of the *septa* with clamp connections.

Habitat: On the ground, the mycelium forming mycorrhiza with trees.
Distribution: Brazil, south to Argentina, also in Liberia, Africa.

Material studied: **Brazil** 1906, *J. Rick*, *31* (*Boletus crassus* but recognized as **authentic** material of *Boletus tropicus* by Rick *in litt.*) (FH). — **Liberia,** Ganta, *G. W. Harley* (FH).

The above materials are identical with each other. *P. tropicus* differs from *P. Braunii* in being somewhat smaller on an average (though large specimens of the former may be as large or larger than small specimens of the latter) and also in the shape of the hymenophore and the size of the pores. *P. tropicus* may yet turn up in the lists of Central American or even Floridan collectors. *P. Braunii* is more accurately known at the time being, but the congenerity and the specific autonomy of both these species cannot be doubted.

P. tropicus has been shown to form a mycelium-crust closely connected with the roots of *Citrus* spp. in Brazil covering the colonies of *Pseudococcus Comstocki* which attack the roots of these citrus after they have been carried there by an ant (*Solenopsis saevissima* var. *moelleri* Forel); these mycelial crusts of the *Phaeogyroporus* are called *criptas* by the Brazilian writers. The *Pseudococcus* living in symbiosis with the fungus is thought to be the immediate reason for the subsequent dying of the trees affected, though the action of an endophytic mycorrhizal fungus weakens the plants sufficiently prior to becoming subject to a fatal attack by the complex of fungus and *Pseudococcus*. This extremely complicated and interesting coöperation of symbiosis, epibiosis and parasitism has been described and illustrated, discussed and compared with an analogous case in Africa, *viz.* the phthiriosis of the coffee tree in Cameroun, by C. R. Gonçalves (Observações sobre Pseudococcus Comstocki (Kuw. 1902) atacando Citrus na Baixada Fluminense. Rodriguesia **4**:179–198. *fig. 1–39*. 1940) and F. R. Milanez (Observações sobre uma estranha doença das laranjeiras. Rodriguesia **4**:199–263, *pl. 1–18*. 1940). Since we have been able to state that *P. tropicus* occurs in Liberia, it would be interesting to find out whether or not it has anything to do with phthiriosis in Cameroun, or what precisely its biological rôle in Africa is.

3. **Paragyrodon** (Sing.) Sing., Ann. Mycol. **40**:25. 1942.
Gyrodon subg. Paragyrodon Sing., Rev. de Mycol. **5**:7. 1940.
Characters of the genus: see key, p. 226. Type species *P. sphaerosporus*

(Peck) Sing. (*Boletus sphaerosporus* Peck). *Paragyrodon* is not represented in the flora of Florida.

4. **Gyrodon** Opat., Comm. Hist.-Nat. Fam. Fung. Bolet., Wiegmann's Arch. **2**(1):5. 1836.

Uloporus Quél., Enchir., p. 162. 1886 (proposed lecto-type *U. lividus*)

Boletinellus Murr., Mycologia **1**:9. 1909 (type *B. merulioides*)

Characters of the genus: Pileus not quite glabrous and inclining to become viscid in wet weather; hymenophore of irregularly arranged (gyrose) or boletinoid, or almost lamellate tubes or honey-combs, arcuate-decurrent; spore print brown or olive brown; stipe not reticulate, not hollow, not glandulose, avelate; context either changing color or unchanging on exposure; spores short-ellipsoid to subglobose, more rarely subcylindric-subreniform (but very short), smooth, brownish; cystidia not differentiated excepting cheilocystidia which are rather inconspicuous; hyphae with clamp connections. Habitat on wood or on the ground, and in the latter case often forming mycorrhiza with *Alnus*, *Fraxinus*. The genus is almost cosmopolitan. Of the six or seven species known, one occurs in Florida.

The type species of *Gyrodon* is *G. sistotremoides* (Fr.) Opat., a synonym of *Boletus sistotrema* Fr., Syst. Mycol. **1**:389. 1821, which would appear to be the legal name of the plant. It has been argued (Kallenbach, Pilze Mitteleuropas **1**(15):113. 1935) that since Opatowski leaves *Boletus lividus*, the well-known European species of *Gyrodon* in the genus *Boletus*, and does not know *Gyrodon sistotremoides* himself, this latter may not be congeneric with *G. lividus*, and may rather be a rare deformation of some species with other affinities. It seems indeed that Karsten's *G. sistotrema* is nothing but *Suillus bovinus* since he indicates the spores as elongate. Despite the fact that Fries cites this description of Karsten's in his *Hymenomycetes Europaei*, this does not necessarily mean that Fries' species is likewise a *Suillus*. In fact, Fries cites at the same time "*B. brachyporus* Rostk." as synonym, and this figure in Sturm's Flora is considered to be a genuine *Gyroporus lividus* (see Gilbert, Bolets, p. 216. 1931). Konrad and Maublanc and other authors think that *G. sistotrema* and *G. sistotremoides* are synonyms of *G. lividus*, and judging from the description which is the only document we have, we admit that there is no good reason for eliminating this species from *Gyrodon* since it may well pass as an extreme form, *G. lividus*. It would thus become a form with more elongated stipe and "whitish" context, and the configuration of the hymenophore described by Fries would find its logical explanation when considered to be of the type observed in old stages of *Gyrodon lividus* rather than by looking for rare deformations in other genera. The secret of *Gyrodon sistotrema* will never be lifted in an absolutely conclusive way, and, as it seems to us, it would be best to let it go at that, and not cause nomenclatoral trouble by refusing "endorsement" of this species as a *Gyrodon sensu stricto*. The

general consensus appears to be rather to model *Gyrodon* along the characters of *Gyrodon lividus* even at the risk of having to conserve the generic name *Gyrodon* in this sense.

KEY TO THE SPECIES

A. Spores medium to large (6)–6.8–11 x 4.7–9 μ; pores wide, later becoming very wide, boletinoid or forming a hymenophore similar to that of *Phylloporus rhodoxanthus*. The American forms not combining bluing context with russet-staining stipe. Not connected with *Alnus*.

B. Pileus "russet"; hymenophore nearly of the *Phylloporus rhodoxanthus* type *G. intermedius*

B. Pileus olivaceous, sepia, or tan-clay-color, not reddish; hymenophore more or less boletinoid.

C. Context and tubes not bluing on injury. 6. *G. proximus*

C. Context and tubes bluing on injury.

D. Stipe usually slightly eccentric to central; carpophores growing neither on fern-trunks, nor in association with *Fraxinus americana*. South American species. *G. Rompelii*

D. Stipe usually strongly eccentric or lateral; carpophores growing either on fern trunks, or in association with *Fraxinus americana*. North America and Asia.

E. Carpophores rather robust, stipe comparatively thick; growing on very decayed wood or on earth in (probably mycorrhizal) association with *Fraxinus americana*. North American species. *G. merulioides*

E. Carpophores thin and small; stipe slender, growing on fern trunks. Javanese species. *G. spec.*

A. Spores small: 4–8 x 3–5 μ; pores rather small but elongate, later becoming irregularly elongate, of varying level, and therefore appearing as if toothed; context strongly bluing; stipe becoming russet-spotted, always associated (probably by mycorrhiza) with *Alnus nigra*, *A. viridis*, *A. incana*. *G. lividus*

6. **Gyrodon proximus** Sing. spec. nov.

Pileo obscure fusco, dein biso vel umbrino, saepe pallescente usque ad alutaceum, tomentoso in centro, subviscido, margine incurvo, dein attenuato, convexo, denique irregulariter applanato, 20–115 mm. lato. Hymenophoro submerulioideo, dein boletinoideo, poris tubulis concoloribus, immutabilibus, inaequalibus, flavis, subviridulis in vetustis; sporis 7–9.5–(9.8) x 4.8–6.2–(6.8) μ, melleo-brunneis; hyphis fibuligeris. Stipite pileo concolori, ut minimum ad basin, gradatim vel subabrupte hymenophoro apicem versus concolori, solido, subglabro, sublevi, 20–63 x 9–15 mm. Carne superficiebus pallidiore, plus minusve alutacea, aeri exposita immutabili; odore subtili vel nullo. Habitatio: Ad terram et ad ligna in silvis humidis Americae subtropicalis tropicalisque.

Pileus initially deep brown ("mummy brown") becoming "bister" or "Saccardo's umber," or "buckthorn brown," in many specimens bleaching to alutaceous ("pinkish buff," "cinnamon buff") or argillaceous ("clay color"), frequently with still paler portions ("cartridge buff"), tomentose, especially in the center, and often shining because of a tendency toward viscidity during heavy rains, with the margin incurved when young, later progressively thinning out and narrowly sterile in most specimens, convex, eventually irregularly flattened, 20–115 mm. broad. — *Hymenophore* "am-

ber yellow" to "wax yellow," or "aniline yellow," assuming a greenish tinge when old, deeply decurrent, tubes rather short, pores concolorous, unchanging, submerulioid, becoming more boletinoid, 0.5–1.3 mm. wide, on unequal level; spore print olive brown. — *Stipe* concolorous with the pileus, in the lower part, or at least at the base, gradually or somewhat abruptly paler and yellower toward the apex, usually reaching the color of the hymenophore just below the pores, both the stipe and the spores, or either of them exuding a chestnut colored watery liquid in some specimens, straight, or curved, eccentric to central, more rarely lateral, solid, 20–63 x 9–15 mm. — *Context* paler than the surface, more or less alutaceous, not changing on injury; odor slight, agreeable, or none.

Spores 7–9.5–(9.8) x 4.8–6.2–(6.8) μ, short-ellipsoid, smooth, honey-brown, occasionally subreniform, with rather thin or medium thick walls, with a short-ellipsoid central oil-drop, or without it; *basidia* 21–43 x 9–9.5 μ, 4-spored; *cystidia* on the pore-mouths (cheilocystidia) fusoid, bottle-shaped, or subulate, 15–17 x 4 μ, neck, if present, 2 μ in diameter; *trama* of the hymenophore truly bilateral, mediostratum slightly denser than the diverging lateral strata; *hyphae* with clamp connections.

Chemical reactions: **KOH** on surface of pileus, deep chestnut, or brown, usually fading to ochraceous but with a dark ring; on context brown. — **NH_3** on surface of pileus, lilac to deep brownish lilac. — **NH_4OH** on surface of pileus, deep chestnut or blackish to lilaceous, with a brownish-lilaceous or lilac ring around the wetted spot; on the context and on the tubes, blue. — **HNO_3** everywhere light reddish brown, reddish brown. — **H_2SO_4** on surface of pileus, deep chestnut; on context, ochraceous brown, or negative; on tubes orange brown. — **Formol** on context, greenish or bluish. — **$FeSO_4$** on tubes, green to blue-green.

Habitat: In moist lime sink hammocks and near creeks in swampy or low hammock vegetation, also said to occur in high hammocks and oak woods, on decaying wood and on the ground, fruiting from February (British Guiana) and June (Florida) to September.

Distribution: Known to occur in north Florida and British Guiana, probably also on Jamaica, apparently all over the Caribbean area.

Material studied: **Fla.** Alachua Co., Gainesville, *R. Singer, F 2649* (FH); *W. A. Murrill, F 18174* (FLAS); Devil's Millhopper, *R. Singer, F 2425* (**type**), *F 2425 a* (FH). — **British Guiana,** Plantation Vryheid, *D. H. Linder, 1005* (FH).[7]

This species differs from *G. merulioides* in having unchanging flesh and tubes, being somewhat more variable in its habit (even more often subcentrally stipitate than lateral), and showing somewhat different chemical reactions. It also differs slightly in the shades and distribution of the colors but this character is not quite reliable. In flat frondose woods, on the ground, it usually assumes the habit of *G. Rompelii* (from which it differs

[7] Specimens from Jamaica without notes cannot be listed as more than probably belonging here: Blue Mts., Morca's Gap, Sept. 21–24, 1908, *E. G. Britton* (det. W. A. Murrill) (as *Boletinus porosus ?*) (NY).

in having unchanging context and hymenophore) whereas, on steep landsides, banks, vertical surfaces of logs, etc., it tends rather to assume the general appearance of *G. merulioides*. The spores are definitely different from these of *G. merulioides* and *G. Rompelii* as well. However, the measurements and the indication of the shape would not clearly express the difference. The spores of all *Gyrodon* are variable in their proportions (Q = length : breadth), but in the bluing American species (*G. merulioides*, *G. Rompelii*), the spores with Q = 1.35 and less are more numerous than in the unchanging species (*G. proximus*) where the spores with Q = 1.45–1.60 are very common. Besides, the bluing species of this continent have spores which frequently, though not always, reach larger figures in length and especially in breadth, than *G. proximus*.

It is not clear what trees this species prefers, if any, and whether or not there is a mycorrhizal relationship between forest trees and the mycelium. There was in my original notes no comment made on a possible association with *Fraxinus*. The type locality has been made the subject of a second floristic analysis,[8] and the species of trees recorded then were: *Liquidambar styraciflua* (the decaying wood on which some of the specimens grew was likewise identified as belonging to sweet gum), *Ostrya virginiana*, *Carpinus caroliniana*, *Quercus virginiana*, also *Evonymus* and *Toxicodendron* were present. *Ulmus alata*, *Magnolia grandifolia*, *Tilia heterophylla*, *Fraxinus americana*, *F. pauciflora* were found farther away. Judging from the experiences with *Gyrodon merulioides* in the northern states, one would be inclined to think that *Fraxinus* is, here too, the mycorrhiza-tree of the *Gyrodon*. But, on the other hand, *Fraxinus* was definitely absent at least from one place where the *Gyrodon* was collected. Aside from this, *Fraxinus* does not occur in British Guiana, and is also not known on Jamaica. Since the specimens from British Guiana can hardly be anything but *G. proximus*, the association with *Fraxinus*, if ever existent farther north, must be flexible enough to allow replacement of this tree by some other species of the *Oleaceae*, or else the occurrence of the fungus is not necessarily restricted to the simultaneous presence of a mycorrhizal symbiont. In this regard, *G. proximus* seems to differ from *G. merulioides*.

EXTRALIMITAL SPECIES

Gyrodon intermedius (Pat.) Sing., Rev. de Mycol. **3**:172. 1938.

Phylloporus intermedius Pat., Bull. Soc. Myc. Fr. **11**:86. 1895.
Suillus intermedius Kuntze, Rev. Gen. Plant. 3^2:535. 1898.
Boletus intermedius Sacc., Syll. **14**:165. 1899.
Boletinellus intermedius Gilbert, Bolets, p. 105. 1931.

The type (FH) from Madagascar has the spores 7.8–9.2 x 5–6.8 μ, and

[8] A floristic paper (Lillian E. Arnold. A Field Trip to the Devil's Millhopper. Jour. E. Mitch. Sci. Soc. **52**(1):77–90. *pl. 7–10*. 1936) dealing with this lime sink vegetation was of great help. The author divides the sink-slopes in four zones. In the higher two zones where my number *F 2425 a* (co-type) was collected, *Fraxinus* has not been indicated.

the hyphae with clamp connections. No mention of the bluing of the context is made in the description. We also have West African material (Liberia, Firestone # 3, July 25, 1926, *D. H. Linder* (det. R. Singer) (FH) that belongs to this species because of the color of the pileus and the shape of the hymenophore, but the spores are slightly smaller (6–9.3 x 4.7–5.5 μ, mostly 6.8–7.8 x 4.8–5 μ); basidia 26–28 x 7.5–11 μ; hyphae with clamp connections. The specimens show larger and more central stipes like *G. Rompelii*, and the flesh turns blue on injury (when fresh) as in the latter. The pileus is "russet" and the hymenophore "lemon chrome" in fresh condition. For the time being, we do not think it wise to separate these forms specifically.

Gyrodon Rompelii (Pat. & Rick) Sing., Rev. de Mycol. **3**:172. 1938.
Phylloporus Rompelii Pat. & Rick, Broteria **6**:81. 1907.

The type and authentic material (FH) has spores exactly as *G. merulioides*, (7.5–10.5 x 6–7.5 μ), and the authors indicate that the fresh context turns blue when broken. The habit is the only visible difference between this and *G. merulioides*. There may be a difference in the chemical characters, and there is one in ecology, since *Fraxinus americana*, the constant accompanying tree of *G. merulioides*, does not occur in Brazil. Yet it may well be that, as indicated by this author in previous papers, *G. Rompelii* is not specifically different from *G. merulioides*. In fact, the author has seen specimens from the southern hemisphere with lateral stipe. The absence of *Fraxinus* at its habitats and the fact that, between the geographic areas of *G. merulioides* and *G. Rompelii*, a gap is noticeable with *G. proximus* replacing the northern and the southern species in the tropical belt, prevent me from reducing *G. Rompelii* to synonymy.

Gyrodon merulioides (Schw.) Sing., Rev. de Mycol. **3**:172. 1938.
Daedalea merulioides Schwein., Trans. Amer. Phil. Soc. II **4**:160. 1832.
Paxillus porosus Berk. *in* Lea, Cat. Plants Cincinnati, Ohio, p. 54. 1839.
Boletus lateralis Bundy *in* Chamberlain, Geology Wisconsin **1**:398. 1883.
Boletinus porosus Peck, Bull. N.Y. State Mus. **8**:79. 1889, *incl. var. opacus*.
Boletinellus merulioides Murr., Mycologia **1**:7. 1909.

This species is so similar to *G. proximus* of Florida that a complete description of our collections appears to be necessary for the comparison of these plants.

Pileus olive brown or brown ("Isabella color" and "light brownish olive" in various combinations), often with darker portions or spots ("mummy brown" or deeper), also darker colored where handled, circular or elongate in circumference, dry, finely subflocculose or glabrous and like kid, or tomentose, or partly so, convex, eventually flattened or concave, 40–110 mm. broad. — *Hymenophore* "old gold" with a flush of "Isabella color," bluing where injured, becoming more brown or green when old or dry, boletinoid to submerulioid, some of the perpendicular walls not reaching the level of the radial (lamellose) walls, decurrent and forming an incomplete or complete wide network of veins on the very apex of the stipe, 4–14

mm. thick, pores irregular, angular, more radially elongate near the margin than farther inside, more than 1 mm. wide in middle zone (seemingly much wider than 1 mm. but the lower connecting walls inconspicuous, and therefore often not taken in consideration); spore print slightly deeper colored than "Isabella color" when quite fresh, and slightly lighter than this in an old print. — *Stipe* "buckthorn brown" and "yellow ocher" at apex, abruptly concolorous with the pileus in the lower portion, and there eventually almost black ("citrine drab" and "clove brown") in some specimens, the very base again paler in some cases, subglabrous, almost smooth, almost constantly either lateral or eccentric, rarely only slightly eccentric-subcentral, curved or straight, solid, 10–34 x 8–18 mm. — *Context* "baryta yellow" to "pinard yellow" in the pileus, "fawn color" to almost "army brown" in the base, often pale brown almost throughout the stipe, becoming dirtier here, and slowly bluing in the pileus when exposed; odor none, or of raw potatoes, or slightly spermatic.

Spores (6.8)–7–11 x 4.8–9.2 μ, mostly 7.5–10.5 x 5.8–9 μ, short-ellipsoid, with well-colored, somewhat thickened walls, smooth; *basidia* about 25 x 10–10.8 μ, 4-spored, with 3.5–4.2 μ long sterigmata; *cystidia* rare, not very conspicuous, cylindric, up to 6.5 μ broad; *trama* of the hymenophore truly bilateral; *cuticle* of the pileus of filamentous, 2–3.5 μ thick hyphae which are incrusted by the pigment, 3–4 μ thick in the cuticle of the stipe, some hyphae thickened up to 15 μ in diameter, and filled with a yellowish sap; most *hyphae* with clamp connections.

Chemical reactions: **KOH** on the surface of the pileus, a dusky mahogany brown; on context, light brown to very deep brown. — **NH_3** on surface of pileus, "Rood's brown." — **NH_4OH** on surface of pileus, very deep brown where it had been brown, more chestnut to paler tan where it had been more olivaceous; on context of pileus provoking the same color as the natural color of the context of the base of the stipe, or becoming dirty salmon color, or dirty gray; on tubes, "Mars brown" to "Prout's brown" (somewhat more sordid than these). — **H_2SO_4** on surface of pileus, as with KOH; on context and tubes, subferruginous. — **Phenol** on context, more blue than by mere autoxydation, eventually becoming brick red. — **$FeSO_4$** on context, olivaceous-green.

Habitat: In open woods and shaded lawns under *Fraxinus americana*, or in its neighborhood, on the soil, or on decayed wood of various trees, usually gregarious, fruiting from June to October.

Distribution: Common in most northeastern states, also in eastern Canada and south to Georgia and Alabama, west to Wisconsin.

G. merulioides has been studied by the author in numerous dried and fresh specimens. D. H. Linder (*in schedulis*) first brought the *Fraxinus*-relation to the author's attention, and then his own observations as well as W. H. Snell's independent experiences (orally to the author) confirmed this relationship. However, in artificial conditions of the laboratory, it is possible that this species may form mycorrhiza with other species than the above mentioned. In fact, it has been shown recently that a fungus de-

termined as *Boletinus porosus* forms mycorrhiza with pines. This, however, if it happens in the laboratory, is not likely to happen in nature.

Gyrodon spec.

One of the undetermined boletes in the Hoehnel Herbarium (FH), collected near Tjibodas, Java, in 1909 on a fern-trunk, *F. v. Hoehnel B.n. 1187* was examined by this writer, and found to belong in *Gyrodon*, more precisely in the *G. merulioides-Rompelii*-group, differing from both *G. merulioides* and *G. Rompelii* in the slender, eccentric stipe, and the much thinner pileus. The spores are 7.8–10.2 x 5.5–6.8 μ, short-ellipsoid, brownish, smooth. It is possible that the habitat is only incidental, and that there is *Fraxinus* near the place where it was collected (*Fraxinus* does occur on Java). It may also be that the thin pileus and slender stipe do not normally characterize the Javanese form. Therefore, I do not think it wise to publish it under a new specific name but merely wish to call the attention of other mycologists to the subject.

Gyrodon lividus (Bull. *ex* Fr.) Sacc., Syll. **6**:52. 1888.

Boletus lividus Bull. *ex* Fr., Syst. Mycol. **1**:389. 1821.
Boletus sistotrema Fr., Syst. Mycol. **1**:389. 1821, *non* Rostk. *in* Sturm.
Boletus brachyporus Pers., Mycol. Eur. **2**:128. 1825.
Gyrodon sistotremoides Opat., Comm. Hist.-Nat. Fam. Fung. Bolet., Wiegmann's Arch. **2**(1):5. 1836.
Boletus rubescens Trog, Flora **22**^{2}:449. 1839.
Boletus lividus ssp. alneti Lindgr. *ex* Fr., Hymen. Eur. p. 519. 1874.
Boletus lividus ssp. labyrinthicus Fr., Hymen. Eur., p. 519. 1874.
Boletus lividus var. rubescens Quél., Ass. Fr. Avanc. Sci., **1885**, p. 7. 1885.
Uloporus lividus Quél., Enchir., p. 162. 1886.
Uloporus lividus var. rubescens Quél., Enchir., p. 162. 1886.
Gyrodon lividus ssp. alneti Sacc., Syll. **6**:52. 1888.
Gyrodon lividus ssp. labyrinthicus Sacc., Syll. **6**:52. 1888.
Gyrodon rubrescens Sacc., Syll. **6**:52. 1888.
?*Boletus gyrosus* Pers., Mycol. Eur. **2**:138. 1825.
?*Boletus caespitosus* Mass., Brit. Fung. Flor. **1**:297. 1892.
?*Gyrodon caespitosus* Sacc., Syll. **11**:81. 1895.
?*Gyrodon Mikhnoi* Karst. (*descr. desid.*) *ex* Gilbert, Bolets, p. 104. 1931.

This is the only species known thus far from Europe but it has not been observed in America. For a description and plate see Kallenbach, Pilze Mitteleuropas **1**:109. *pl. 10, fig. 4–7*; *pl. 39, fig. 1–22*; *pl. 44, fig. 70–72*, and for the microscopical characters R. Singer, Rev. de Mycol. **3**:172. 1938.

SPECIES INCOMPLETELY KNOWN

Gyrodon purpureus (Beeli) Sing., Rev. de Mycol. **3**:171. 1938.

Favolus purpureus Beeli, Bull. Soc. Roy. Bot. Belg. **58**:213. 1926.
Boletinellus purpureus Gilbert, Bolets, p. 105. 1931.

This species from the Belgian Congo has been admitted in *Gyrodon* by this author conditionally ("Si ce que M. Gilbert affirme relativement au *Favolus purpureus* est exact..."), on the authority of Gilbert who has seen the type.

Gyrodon Ledermannii Kallenbach, Zeitschr. Pilzk. **8**:96. 1929, *ad int.*

Described from New Guinea, this species is too incompletely characterized.

SPECIES EXCLUDENDAE

Gyrodon capensis Sacc. is *Phlebopus capensis* (Sacc.) Sing.
Gyrodon castanellus (Peck) Sing. see under *Xerocomus squarrosoides* (Snell) Sing.
Gyrodon Emilei (Barbier) Killermann, Denkschr. Bayer. Bot. Ges. Regensb. **16**:22. 1925 is *Boletus spec.*, probably *B. aff. rubellus* Krombh.
Gyrodon filiae (Gill.) Sacc. & Cub. is *Boletus edulis* Bull. *ex* Fr. (a monstrosity)
Gyrodon fusipes (Heufl. *in* Rab. Exs.) Sacc. is *Suillus placidus* (Bon.) Sing.
Gyrodon immutabilis (Britz.) Sacc. & Trott. is a *Boletus* spec., possibly *B. appendiculatus*; according to Killermann, it is *Phlebopus sulphureus* (Fr.) Sing.
Gyrodon miramar (Roll.) Sacc. & Trott. is *Suillus granulatus* (L. *ex* Fr.) Kuntze (*sec.* Konrad & Maublanc)
Gyrodon Mougeotii (Quél.) Sacc. is *Boletus pulverulentus* Opat. (*sec.* Konrad & Maublanc)
Gyrodon Oudemansii (Harts. *in* Flor. Bat.) Sacc. is *Suillus placidus* (Bon.) Sing.
Gyrodon placidus (Bon.) Sacc. is *Suillus placidus* (Bon.) Sing.
Gyrodon rubellus McWeeney *fide* Rea is not a *Gyrodon*.
Gyrodon volvatus (Pers.) Opat. is a parasitized or anomalous *Amanita* spec.

Subfam. **Suilloideae** Sing. subfam. nov.

Hyphis fibuligeris vel haud fibuligeris; hymenophoris boletinoideis (parietibus lamellose i.e. radialiter dispositis) aut velatis aut glandulosis (glandulis numerosioribus ad stipitem) aut — si characteribus his carent — pellicula viscosissima praesente et tunc sporis constanter minoribus, pallide melleis elongatis, cystidiisque plerumque incrustatis et majusculis, stipite plerumque cylindrico vel subcylindrico, hymenophoro plerumque haud distincte depresso circum stipitis apicem et tramate distincte bilaterali praedito; si autem his characteribus haud clare gaudet, tubuli ex integro rubidi sunt. Habitatio: Cum arboribus coniferis mycorrhizam formant.

Characters of the subfamily: see key, p. 226, and Latin diagnosis.

The genera *Boletinus*, *Psiloboletinus*, and *Suillus* have very decidedly a close and natural affinity notwithstanding the difficulties one experiences in briefly outlining the characters they have in common, as may be seen in the above Latin description of this subfamily. When working on these fungi one cannot fail to notice that there is a much closer relationship between all these genera than between any one of them and any other boletaceous genus.

5. **Psiloboletinus** Sing. gen. nov.

A genere *Boletino* veli absentia et hymenophoro magis lamelloideo marginem pilei versus differt.

Characters of the genus: see key p. 226 and the above Latin diagnosis. The type species is **P. lariceti** (Sing.) Sing. comb. nov. (*Phylloporus lariceti* Sing.)

At the time of the discovery it seemed wiser to refrain from the erection of a new genus for what we then called *Phylloporus lariceti*. A more pro-

found study of the affinities of this species, however, as well as of *Phylloporus rhodoxanthus* has become possible since then and, as a result, we now propose to base a new genus of Suilloideae on the former while the latter enters the subfamily Xerocomoideae as the type species of *Phylloporus*. The ecology and the chemical characters of *P. lariceti* and *P. rhodoxanthus* make this disposition necessary. *Psiloboletinus* does not occur in Florida.

6. **Boletinus** Kalchbr., Bot. Zeit. **25**:182. 1867.

Euryporus Quél., Enchir. p. 163. 1886. Type, *E. cavipes* (Opat.) Quél.

Characters of the genus: Pileus fibrillose to squamose, or even squarrose, the fibrils or scales not superimposed upon a viscid layer and therefore not easily detersible as fragments of a veil, the surface decidedly dry even in wet weather except for *Boletinus spectabilis* when the pileus becomes viscid starting from the margin and gelatinizing inwards; spores comparatively small to medium (up to 13.2 μ in our measurements) pale melleous with occasional darker spores, cystidia voluminous and mostly covered by a resinous colored incrustation; clamp connections potentially present in most species, i.e. at least some populations or carpophores of a majority of species have at least some scattered clamps while in some species a majority of specimens does not show clamps at all, and in some species, clamp-bearing specimens have not yet been found; hymenophore more (in the majority of cases) or less (especially in *B. amabilis* and *B. pictus*) boletinoid, *i.e.* pores radiately arranged and rather long, the radial walls lamella-like, especially toward the stipe; stipe usually cylindric or subcylindric and constantly without glandulae (some glandulae might however be seen on the pores if a lens is used); veil always present though not always persistent and not regularly forming an annulus, either simple or double; mycelium connected with certain conifers (*Pinus*, *Larix*, *Picea*, *Pseudotsuga*) with which all Boletini are associated, forming mycorrhiza. The type species is *Boletinus cavipes* (Opat.) Kalchbr. (*Boletus cavipes* Opat.).

KEY TO THE SUBGENERA AND SECTIONS

A. Stipe hollow, or, if solid, the pores comparatively extremely wide; mycorrhiza always with *Larix*; clamps constant. Subgenus *Eu-Boletinus*

B. Stipe hollow. Sect. *Cavipedes*

B. Stipe solid. Sect. *Palustres*

A. Stipe solid; pores medium-wide to wide, not as wide as in the sect. *Palustres* if the size of the pileus is considered; clamps either not constant, or very scattered, or even entirely absent in all the material studied thus far. Subgenus *Aporpiellus*

C. Veil duplex, the interior veil gelatinizing and forming a glutinous inner layer of the annulus and a viscid marginal zone in older specimens. Sect. *Spectabiles*

C. Veil simple or double but neither layer gelatinizing with age. Sect. *Solidipedes*

Subgen. **Eu-Boletinus** Sing. subg. nov.

Hyphis fibulis numerosis constanter instructis; stipite interdum cavo; mycorrhiza cum larice.

Characters of the subgenus: see key and Latin diagnosis above. Type species *Boletinus cavipes* (Opat.) Kalchbr.

Sect. **Cavipedes** Sing., Rev. de Mycol. **3**:163. 1938.

Characters of the section: Stipe hollow; pileus squamose; hymenophore strongly boletinoid, pores wide but not as extremely wide as in the *Palustres*; veil not gray; gelatinizing surfaces absent; spores often small (smaller than 10 μ in a majority of cases); clamp connections numerous and constant; context unchanging. The type species is *B. cavipes* (Opat.) Kalchbr. Another species is *B. asiaticus* Sing. None of these has been observed in Florida.

Sect. **Palustres** Sing., Rev. de Mycol. **3**:162. 1938.

Characters of the section: Stipe solid; pileus squamose; hymenophore strongly boletinoid, pores extremely wide in comparison with the size of the pileus; spores small (smaller than 10 μ); clamp connections numerous and constant; hyphae of the cuticle with a wall of about 1 μ diameter, grayish-fuscous in ammoniacal medium; context unchanging on the air but somewhat more readily reacting with chemical reagents, especially $FeSO_4$.[9] Type species *B. paluster* (Peck) Peck. No representatives are known in Florida.

Subgen. **Aporpiellus** Sing. subg. nov.

Fibulis haud praesentibus in omnibus carpophoris (i.e. inconstantibus) et si adsunt, haud praesentibus in omnibus septis (i.e. infrequentibus); stipite nunquam cavo; mycorrhiza cum larice et aliis arboribus coniferis.

Characters of the subgenus: See key and Latin diagnosis above. Type species *B. pictus* (Peck) Peck.

Sect. **Spectabiles** Sing., Rev. de Mycol. **3**:157. 1938.

Characters of the section: Veil duplex, i.e. interior veil membranaceous and gelatinizing in the annulus and on the margin of the pileus; exterior layer squamulose; hyphae of the pileus thin-walled; stipe solid; clamp connections none, or in some specimens present though very rare. The only species known is *B. spectabilis* Peck, forming mycorrhiza with larch, and therefore not occurring in Florida.

[9] In *B. paluster*, the "carmine" color of the scales becomes more vivid with formol which also provokes at times a very slight reddening of the context; KOH on surface of pileus black for about 1 second, then pale brownish; on context red for about one second, then lilac, then sordid; NH_4OH on surface of pileus, darker and then quickly bleached; on context, darker yellow; $FeSO_4$ on stipe, greenish gray. The whitish yellow to lemon yellow context of the pileus, and the pale orange context of the stipe, the more reddish context of the base and the "Isabella color" pores and tubes are not subject to autoxydation.

Sect. **Solidipedes** Sing., Rev. de Mycol. **3**:158. 1938.

Characters of the section: Veil double or simple but not showing different consistency in age, the whole plant remaining dry, never viscid, or scarcely so; stipe solid, eventually sometimes slightly excavated; pores wide (about as wide as in the sect. *Cavipedes*, or smaller), in two species (*B. amabilis*, *B. pictus*) not quite as distinctly boletinoid as usual in the other sections; veil frequently tending to be or to become gray. Type species *B. pictus* (Peck) Peck.

This section is the one richest in species, and also shows the greatest variation in distribution and in ecologic requirements. The author formerly (Rev. de Mycol. **5**:6. 1940) transferred *Boletus Lakei* to *Ixocomus* (i.e. *Suillus*) but further studies on this species and allied forms have shown that it belongs in *Boletinus* rather than *Suillus*. It grows with *Pseudotsuga*. *B. Benoisii*, *B. grisellus*, most forms of *B. oxydabilis* and *B. ochraceoroseus* grow with larch and *B. amabilis* has been indicated with *Picea*. Naturally, these species do not occur in Florida. Of the species associated with pine, *B. pictus* does not occur so far south, thus only *B. decipiens* is found in the pine woods of this state.

KEY TO THE SPECIES

A. Context distinctly and strongly (in young fresh specimens) changing color when bruised; annulus often gray or tending to become so; mycorrhiza with *Pinus*, or with *Larix sibirica* or *L. dahurica*; pileus "Vandyke red" to "acajou red" when young, if growing with pine.

B. Mycorrhiza with *Pinus*. *B. pictus*

B. Mycorrhiza with *Larix*.

C. Pileus deep raspberry-red to bright brick red; mycorrhiza with *Larix dahurica*. *B. Benoisii*

C. Pileus merely with an occasional purplish brick color shade; mycorrhiza with *Larix sibirica*. *B. oxydabilis*

A. Context slightly changing color over very limited areas when broken, or indistinctly and inconstantly discolored after rather long exposure to the air, or not changing at all; annulus not gray; pileus never entirely "Vandyke red" or "acajou red"; fungi forming mycorrhiza with *Pinus*, *Larix* (but not *L. dahurica* nor *L. sibirica*), *Pseudotsuga*, *Picea*.

D. Mycorrhiza with *Larix occidentalis* and other species of *Larix*.

E. Spores around 4–5 μ broad; pileus never pinkish. *B. grisellus*

E. Spores around 3–3.5 μ broad; pileus inclining to pink. *B. ochraceoroseus*

D. Mycorrhiza with other conifers than *Larix*.

F. Mycorrhiza with *Pseudotsuga* or *Picea*; western species.

G. Spores around 4.2 μ broad and (9.5)–11–(12.3) μ long. *B. amabilis*

G. Spores around 3.5 μ broad and (7)–8.5–(10.7) μ long. *B. Lakei*

F. Mycorrhiza with *Pinus*; eastern species. 7. *B. decipiens*

DESCRIPTION OF THE FLORIDA SPECIES

7. **Boletinus decipiens** (Berk. & Curt.) Peck, Bull. N.Y. State Mus. **8**:78. 1889.

Boletus decipiens Berk. & Curt., Ann. Mag. Nat. Hist. II, **12**:430. 1853.
Suillus decipiens Kuntze, Rev. Gen. Plant. **3**²:535. 1898.
Boletinus Berkeleyi Murr., Mycologia **1**:6. 1909.
Boletinus floridanus Murr., Lloydia **6**:224. 1943.

PLATE I, FIG. 5–7.

Pileus "maize yellow" or paler, with "cinnamon buff" or "clay color" scales, sometimes becoming somewhat "Verona brown" after rains, not viscid at any time, the scales irregular, rather small (1–2 mm. in diameter), appressed, the surface convex, not or indistinctly umbonate, 35–70 mm. broad. — *Hymenophore* "deep colonial buff," nearing "honey yellow" when mature, typically boletinoid and very compound, adnato-decurrent, the decurrent tooth running down over about one third to one half of the stipe's length, and this decurrent portion usually entirely covered by the veil, tubes moderately long, pores concolorous. — *Stipe* "cinnamon buff," or, especially below, "pinkish cinnamon," frequently with some "Sudan brown" below, with an incomplete and not quite constant network immediately below the fertile zone of the apex, solid, tapering downwards, 30–36 x 10–12 mm.; veil "pale pinkish buff" to "tilleul buff," apical, dry, fibrillose, appressed, rarely forming a well-developed annulus; mycelium sordid. — *Context* of the pileus and the apex of the stipe "pinkish buff," of the middle of the stipe "straw yellow," of the base "orange cinnamon," most of the context unchanging but at places becoming "vinaceous tawny" (reddening) in the pileus on prolonged exposure; odor agreeable but different from the agreeable odor of the Suilli, not strong; taste mild.

Spores 7–10.5 x 3–4.2 μ, mostly 8.7–9.5 x 3.5–3.7 μ, pale brownish or pale melleous, smooth, more or less cylindric to subfusoid or subellipsoid, decidedly asymmetric, with rather thin wall; *basidia* 24–30 x 6–8.5 μ, 4-spored, the spores formed on sterigmata of the usual shape (half-sickle-shaped), 7 μ long; *cystidia* up to 50 x 13 μ, usually clavate to subfusoid, incrusted by a ferruginous-fulvous, rarely hyaline incrustation; *tramal hyphae* without clamp connections, truly bilaterally arranged; *hyphae of veil* clampless, 1.5–8 μ in diameter; *hyphae of the cuticle* in interwoven strands of parallel filaments, hyaline, with hyaline or brown punctate incrustations or entirely golden-ferruginous at places, the terminal members often clavate, many with a mucilaginous incrustation, the walls very thin to moderately thick, the diameter 3–11 μ, the septa without clamps.

Chemical reactions: **KOH** on surface of pileus, green-black; on context of stipe, green-black, almost black; **NH_3** on surface of pileus, pink and on context of stipe, "cinnamon russet"; **NH_4OH** on surface of pileus, rusty-brown or after a short time becoming sordid blackish lilac; on context of stipe, "cinnamon russet," then slowly almost black; **HNO_3** on surface of pileus, negative; on context of stipe, "cinnamon rufous"; **$FeSO_4$** in all parts, slowly black.

Gastroid condition: Some of the smaller carpophores of the same mycelium do not, at some localities, open up at all and remain indefinitely in a Gasteromycete-like condition; they are piriform with columella (stipe) and labyrinthiform loculi (hymenophore) confined to the underside of a pileate portion of the peridium (pileus), producing spores of the same size (7–9.5 x 3–3.8 μ), shape, and color, on basidia of the same type as in the pseudoangiocarpous form.

Habitat: On the ground in flatwoods and in sphagnose swamps under *Pinus palustris, P. caribaea* and possibly other species.

Distribution: Southeastern states of the U.S.A. north to New Jersey and west to Kentucky (according to Murrill); occurring throughout Florida but rarely collected.

Material studied: **Fla.** Alachua Co. east of Gainesville, July 20, 1943, *R. Singer, F 2840* (FH); Lake Co., Eustis, Oct. 1897, *R. Thaxter* (det. Singer) (FH); Dade Co., Addison Hammock, February 2, 1906, *J. K. Small* (det. W. A. Murrill) (NY). **S.C. type** and **authentic** material from Society Hill and Santee Canal (*1312*) and *Ravenel (401)* (FH). **Ala.** Auburn, *F. S. Earle* (FH); other specimens in the herbaria consulted are not in good condition, and have therefore not been studied carefully, or they obviously belong to other species such as *Xerocomus squarrosoides* (Snell) Sing. or *Gyrodon merulioides*, etc.

Peck correctly transferred this species to *Boletinus*. Whether his own collections belong to *B. decipiens* is not quite certain, but inconsequential. Specimens in the Curtis Herbarium, collected by Peck, are not too convincing, and may belong to *B. pictus*. Material from Maine may belong to *B. cavipes*. All Massachusetts material known to me is *Xerocomus squarrosoides*.

The existence of gastroid forms is considered by this author as an additional evidence of the affinity of the Boletineae and certain Gasteromycetes. These forms are fructifications with incomplete individual development, not reaching the second gymnocarpous stage characterizing *Boletinus* in general. If the Boletineae as a whole are, as this writer thinks, derived from certain Gasteromycetes such as *Truncocolumella* and related forms, it would follow that the gastroid forms of *Boletinus decipiens* are atavistic aberrations whose formation may be favored by climatic factors, e.g. sudden decrease in humidity during the fruiting period. Specimens were sent to Dr. S. M. Zeller of Corvallis, Oregon with the pointed question as to similarity with gasteromycetous genera. Dr. Zeller replied that "the gasteromycetoid stage of *Boletinus decipiens* was received in good condition. It comes closer to *Truncocolumella* than any other described genus of Gasteromycetes, I believe." It ought to be noted well that this comes from the author of the genus *Truncocolumella*, an undoubtedly gasteromycetous genus with the spores borne acrogenously on the sterigmata. It is worth remembering that this genus had been described, shortly afterward, as *Dodgea* by Malençon, and that *Dodgea* was the main subject of discussions on boletinoid affinities by Malençon and this author. With these facts at hand, it

would certainly not be a scientific approach to shut the eyes and talk of convergence.

EXTRALIMITAL SPECIES

Boletinus pictus (Peck) Peck, Bull. N.Y. State Mus. **8**:77. 1889.
Boletus pictus Peck, Ann. Rep. N.Y. State Cab. **23**:128. 1872.
Boletus Spraguei Berk. & Curt., Grevillea **1**:35. 1872.
Boletus Murraii Berk. & Curt., Grevillea **1**:36. 1872.

The pileus of fresh material is "Vandyke red," margin "acajou red," scales "burnt lake," later "Pompeian red" with the scales "brick red," and the yellow of the flesh showing through; pores somewhat paler and yellower than "old gold"; stipe "acajou red" above or "acajou red" to "brick red," or with the base "brick red" to "Hessian brown" (actually this is the color of almost reticulate fibers which are appressed to the "antimony yellow" to "light orange yellow" ground); mycelium dirty whitish; context of the pileus "straw yellow," soon becoming clouded with pinkish to grayish, context of the stipe "mustard yellow," of the base "ochraceous tawny," soon becoming more "tawny" because of autoxydation; veil densely cortinoid-fibrillose, initially "light pinkish cinnamon" becoming "tilleul buff" and eventually gray in the outermost layer. — KOH on flesh of pileus, deep olive, becoming blackish olive to black; $FeSO_4$ on flesh of pileus, deep sordid olive; formol on flesh of pileus, incarnate; NH_4OH as with KOH but reaction weaker.

Boletinus Benoisii (Lebedeva *ex*) Sing., Rev. de Mycol. **3**:159. 1938.

Occurring under *Larix* instead of under pines, this seems to be specifically different from *B. pictus*.

Boletinus oxydabilis Sing., Rev. de Mycol. **3**:160. 1938.

For the complete data on this species and its variety see the original description (*l.c.*) of the Siberian type.

Boletinus grisellus Peck, Mem. N.Y. State Mus. **3**:169. 1900.

Described from Massachusetts, but rather profusely distributed, this species has been described by Peck (*l.c.*), Murrill (N. Am. Fl. **9**(3):159. 1910), Singer (*l.c.* p. 162), and others. Type specimens are preserved (NYS, FH).

Boletinus ochraceoroseus Snell, Mycologia **33**:35. 1941.

Described from Idaho, this species has later been proved to be associated with *Larix* (see Slipp & Snell, Lloydia **7**:18. 1944). The type (FH) appears to be different from *B. Lakei* and *B. amabilis*.

Boletinus amabilis (Peck) Snell, Lloydia **7**:17. 1944.
Boletus amabilis Peck, Bull. Torr. Bot. Club **27**:612. 1900.

Described from spruce woods in Colorado, part of the type is preserved

at FH, and the spores were found to be decidedly larger than in *B. Lakei.* Judging from what material I had, I found it difficult to believe that *B. amabilis* as described by Slipp & Snell (*l.c.*) is the same as the type of this species. The description fits much better in *B. Lakei* which actually is associated with *Pseudotsuga.* Whether or not this and the following species are races or forms, cannot be decided with certainty.

Boletinus Lakei (Murr.) Sing. comb. nov.

Boletus Lakei Murr., Mycologia **4**:97. 1912.
Ixocomus Lakei Sing., Rev. de Mycol. **5**:6. 1940.

Though the specimens received by this author in 1939 from Dr. Alexander H. Smith were identical with the type specimens (NY), they do not seem to belong in *Suillus* now that the related species, *B. amabilis* and *B. ochraceoroseus*, have been studied and found to belong in *Boletinus.* The section *Pseudotsugini* of *Ixocomus* is therefore to be abandoned as a synonym of the section *Solidipedes* of *Boletinus.*

SPECIES INCOMPLETELY KNOWN

Boletinus appendiculatus Peck, Bull. Torr. Bot. Club **23**:418. 1896, from Washington, D. C.

Boletinus solidipes Peck, Bull. N.Y. State Mus. **167**:38. 1912, from Maine.

Boletinus subgrisellus Sing. *ad int.*, Ann. Mycol. **40**:27. 1942 *nom. subnud.*

Boletinus glandulosus Peck, Bull. N.Y. State Mus. **131**:34. 1909, from Nova Scotia.

SPECIES EXCLUDENDAE

Boletinus castanellus Peck.

This is hardly a *Boletinus.* No type is preserved and the species, as understood by some is *Gyrodon merulioides*, or as understood by others, e.g. Coker and Beers, is *Xerocomus squarrosoides* (Snell & Dick) Sing.

Boletinus flavoluteus Snell *apud* Snell & Dick is a *Suillus.*

Boletinus merulioides (Schw.) Coker & Beers, is a *Gyrodon, G. merulioides.*

Boletinus porosus (Berk. *in* Lea) Peck is also *G. merulioides.*

Boletinus punctatipes Snell & Dick is *Suillus punctatipes.*

Boletinus squarrosoides Snell & Dick is not a *Boletinus.* It can be considered as either a *Phylloporus* or a *Xerocomus, X. squarrosoides* (Snell & Dick) Sing.

7. **Suillus** Micheli *ex* S. F. Gray, Nat. Arr. Brit. Pl. **1**:646. 1821 emend. Snell, Mycologia **34**:406. 1942.

Pinuzza Micheli *ex* S. F. Gray, *l.c.* (type *Pinuzza flava* (Bolt.) S. F. Gray)
Rostkovites Karst., Rev. Mycol. **3**:16. 1881 (proposed lecto-type *R. granulatus* (L.) Karst.)
Cricunopus Karst., *l.c.* (proposed lecto-type *C. luteus* (L.) Karst.)
Boletus Dill. *ex* Fr. *sensu* Karst., *l.c.* p. 17, *non* S. F. Gray.

Viscipellis Quél., Enchir. p. 155. 1886 (proposed lecto-type *V. lutea* (L.) Quél)
Versipellis Quél., *l.c.* p. 157 [10]
Ixocomus Quél., Flore Mycol. p. 411. 1888 (proposed lecto-type *I. luteus* (L.) Quél.)

Characters of the genus: Hyphae of the pellicle strongly gelatinized; spores usually small; cystidia usually rather large, incrusted; pileus more or less viscid to glutinous; pores small and round to very wide and boletinoid; tubes adnate and rarely slightly depressed around the stipe, more often subdecurrent or decurrent; trama of the hymenophoral walls truly bilateral, of the *Boletus*- or *Boletinus*-type, not of the *Phylloporus* type; stipe usually more or less cylindric, with or without glandulae (consisting of fascicles of dermatocystidia, or consisting of hyphae terminating in dermatocystidia of two types, dermatopseudoparaphyses and dermatobasidia); spore print either between "ochraceous tawny" and "Isabella color" or a rather deep olivaceous; veil either present or absent, either entirely glutinous-gelatinous, or membranaceous and viscid when wet; mycorrhiza with conifers only. The type species is *S. luteus* (L. *ex* Fr.) S. F. Gray (*Boletus luteus* Linné *ex* Fr.).

From viscid species of *Pulveroboletus*, this genus differs in several regards, *either* by the characters of the veil, indicated above, *or* by the more boletinoid hymenophore if the pores are wide, *or* by forming mycorrhiza with coniferous trees instead of frondose trees, or by a combination of characters like these. The presence of a viscid veil, or glands, or red hymenophore, or boletinoid hymenophore on a species which is constantly associated with conifers suffices to consider it as a *Suillus*, if it is *not* a *Boletinus* (see key, p. 226). The only *Pulveroboletus* known to have a glutinous veil, *P. corrugatus* (Pat. & Baker)Sing. (*Boletopsis corrugata* Pat. & Baker) is a tropical Asiatic species, not associated with conifers. Similar characters or alternative characters or combinations of characters delimit *Suillus* from viscid species of other genera (*Xerocomus badius*, *X. brasiliensis*, *Leccinum rubropunctum*, *L. chalybaeum*, *Boletus Frostii*, *Tylopilus plumbeoviolaceus*, and others) of the Boletaceae, and *Boletellus* of the Strobilomycetaceae.

The author has formerly divided the present genus into four sections, and though he has studied numerous additional species since then, he still sees no reason to change this very workable and natural arrangement. The largest section, *Granulati*, in fact the only one that occurs in Florida, has been subdivided by this author in two subsections. In the light of recent studies it appears that a third subsection should be added in order to take care of the species with weak alkali-reactions and deeper olive spore print,

[10] It is here proposed to accept Murrill's proposal to choose the first species of the genus *Viscipellis*, *V. variegata*, as type of the genus. *Versipellis* also contains elements of *Xerocomus* and *Boletus*, *Phlebopus*, etc. The same approach was also thought to be most practical in the case of the genus *Rostkovites* Karst.

i.e. *S. hirtellus*, *S. punctipes*, *S. cembrae*. The sections and subsections of *Suillus* represent themselves, thus, in the following way:

KEY TO THE SECTIONS AND SUBSECTIONS

A. Stipe with a veil, without glandulae; mycorrhiza with *Larix*. Sect. *Larigni*

B. Pores usually grayish or cinnamon-orange, rarely yellowish, more than 1 mm. in diameter, rarely about 1 mm. in diameter. Subsect. *Megaporini*

B. Pores yellow to ochraceous-olive, less than 1 mm. in diameter, reaching 1 mm. only in old, large fruiting bodies. Subsect. *Leptoporini*

A. Stipe either without a veil, or with glandulae, or, at the same time, without a veil and with glandulae; mycorrhiza with *Pinus*, *Picea*, *Abies*, *Pseudotsuga*, *Tsuga*, and possibly with other conifers, not with *Larix*.

C. Glandulae present (except sometimes in *S. brevipes* where they may be so indistinct as to appear lacking); if they are seemingly absent, the stipe remains white for a long time. Sect. *Granulati*

D. Spore print between "ochraceous-tawny" and "Isabella color"; pores small to wide; context of the pileus with a distinct reaction with NH_3 (red or lilac); pileus without innate fibrils and squamulae.

E. Pores more than 1 mm. in diameter or about 1 mm. wide; veil present but often either gelatinized and entirely glutinous, or reduced to a marginal veil that is rather fugacious. Subsect. *Latiporini*

E. Pores small, decidedly below 1 mm. in diameter (some pores may become 1 mm. in diameter when old in very large specimens); veil well developed, or indistinct, or absent. Subsect. *Angustiporini*

D. Spore print deeper olive; pores around 1 mm. in diameter, occasionally either less or more; context of the pileus with a markedly weak reaction with NH_3 (almost or quite negative at first, after very long exposure becoming sordid to gray or violet); pileus with an innate fibrillosity at least at first, or fibrillose-squamulose-hirtose. Subsect. *Hirtellini*

C. Glandulae entirely lacking; stipe colored from the beginning.

F. Pores and tubes not reddish in fresh condition. Sect. *Bovini*

G. Pores large (larger than 1 mm. in diameter); pileus not squamulose; context with NH_3 dark rose, then red, and eventually brownish vinaceous. Subsect. *Euryporini*

G. Pores small to medium (1 mm. or slightly less in diameter); pileus squamulose; context reacting indistinctly with NH_3 (reddish-lilac) Subsect. *Stenoporini*

F. Pores and at least a portion of the tubes colored a dull red or rose-red in fresh condition. Sect. *Piperati*

Sect. **Larigni** Sing., Rev. de Mycol. **3**:38. 1938.

Characters of the section: see key. Type species: *Suillus Grevillei* (Kl.) Sing. (*Boletus Grevillei* Kl.), also type of subsect. *Leptoporini* Sing. *l.c.*

Subsect. **Megaporini** Sing., Rev. de Mycol. **3**:41. 1938.

Characters of the subsection: see key. Type species: *Suillus aeruginascens* (Secr.) Snell (*Boletus aeruginascens* Secr.). Other species: **Suillus**

flavus (With. *ex* Fr. *sensu* Bres., Nüesch) Sing. comb. nov. (*Boletus flavus* With. *ex* Fr. *emend.* Bres., *Ixocomus flavus* (*sensu*) Sing.); **S. tridentinus** (Bres.) Sing. comb. nov. (*Boletus tridentinus* Bres.). None of these have been observed in Florida.

Sect. **Granulati** Sing., Rev. de Mycol. **3**:38. 1938.

Characters of the section: see key. Type species: same as type of genus.

Subsect. **Latiporini** Sing., Rev. de Mycol. **3**:45. 1938.

Characters of the subsection: see key above. Type species: **Suillus flavidus** (Fr. *ex* Fr.) Sing., comb. nov. (*Boletus flavidus* Fr.). Other species: **S. sibiricus** (Sing.) Sing. comb. nov. (*Ixocomus sibiricus* Sing.); *S. americanus* (Peck) Snell; *S. subaureus* (Peck) Snell; *S. flavoluteus* (Snell) Sing. comb. nov. (*Boletinus flavoluteus* Snell), and some more, none of them occurring in Florida.

Subsect. **Angustiporini** Sing., Rev. de Mycol. **3**:45. 1938.

Characters of the subsection: see key above. Type species: *S. granulatus* (L. *ex* Fr.) S. F. Gray.

KEY TO THE SPECIES [11]

A. Glandulae manifest, in occasional forms with indistinct glandulae and then stipe elongate (longer than the diameter of the pileus) and mycorrhiza not formed with 2-needle pines (at least in nature).

B. Veil present, forming a distinct and constant though not always persistent annulus.

C. Stipe about six times longer than thick, or more, with numerous glandulae almost to the base; annulus small to medium sized, not very distant, and not broadly sheathing, pallid and frequently appressed, sliding down in some instances; mycorrhiza with 5-needle pines (*Pinus strobus* and *P. monticola*). *S. subluteus*

C. Stipe and annulus not as described above; mycorrhiza with 2-needle pines (in nature).

D. Context a warm yellow; annulus very strikingly sheathing and not distant in its free part; mycorrhiza with *Pinus taeda*, *P. palustris*, *P. australis*. 8. *S. cothurnatus*

D. Context white to partially lemon yellow; annulus sheathing but widely distant in its free portion when normally developed in not too old specimens; mycorrhiza in nature with *Pinus pinea*, *P. silvestris*, *P. nigra*, *P. montana*, *P. resinosa*. *S. luteus*

B. Veil absent or indistinct, never forming annulus.

E. Pileus white or white for the most part and for a very long period; stipe elongate; NH_3-reaction red in mature specimens; mycorrhiza with 5-needle pines. *S. placidus*

[11] This key, as usual, takes into account all species known to the author, and will be useful to determine, in this particular case, those species occurring in the eastern United States, eastern Canada, and Europe.

E. Pileus yellow to brown, more rarely initially white but soon with brown and eventually often with yellow shades, or pallescent from the center; stipe short or elongate; NH_3-reaction not distinctly reddish in mature (though not too yellow) context; mycorrhiza with various sections of *Pinus*.

F. Spores larger than 8.2 μ. European and African races of *S. granulatus*.

G. Central and North European form with elongate stipe, yellow to yellowish brown pileus, and concolorous glandulae which become darker only in some specimens and then very late; preferring calcareous soil; associated with *Pinus silvestris* and *P. montana*.
S. granulatus ssp. *typicus*

G. Mediterranean form with short stipe, white to yellowish brown or fuscous pileus, strongly colored grandulae, and preference for sandy soil, not growing with *Pinus silvestris* in nature. *S. granulatus* ssp. *leptopus*

F. Spores smaller than 8.2 μ; associated with *Pinus strobus* (and *P. monticola* ?), rarely with other conifers such as *Abies*.

H. Glandulae conspicuous, not limited to the apex of the stipe; tubes adnate; veil rarely present.
S. granulatus ssp. *Snellii*

H. Glandulae minute, present only at apex of stipe; tubes decurrent; veil marginal, usually rather distinct.
S. albidipes

A. Glandulae very indistinct and small, pallid to brownish, confined to the upper third of the frequently very short stipe, or more often entirely lacking, at least to the unaided eye; mycorrhiza with 2-needle pines. 9. *S. brevipes*

DESCRIPTION OF THE FLORIDA SPECIES

8. **Suillus cothurnatus** Sing. spec. nov.

PLATE I, FIG. 8–10.

Pileo approximate coloribus *S. lutei* gaudente, viscoso, glabro, levi, 16–63 mm. lato; tubulis ochraceo-alutaceis, olivascentibus in vetustis, poris subconcoloribus, exiguis; sporis 7.5–9.8 x 2.7–3.5 μ, levibus, pallide melleis; stipite albido, griseolo, pallide aurantiaco-flavello, saepe fuscescente, glandulis pallidis fulvescentibus vel nigrescentibus adornato, solido, annulato, 23–40–(60) x 4–11–(13) mm.; annulo pallido, olivascente vel grisente, ample cothurnante, membranaceo, viscido; mycelio salmoneo; carne marmorata, aurantiaco-alutacea vel aurantiaca atque carneo-alutaceo-flammata, vel pallide alutaceo-maculosa. Habitatio: Prope pinus (*Pinus australis*, *P. palustris*, *P. taeda*) in Florida Americae Borealis. Distinguntur duae subspecies, ssp. **aestivalis** Sing. (subspecies typica) stipite elongato, et ssp. **hiemalis** Sing., stipite breviusculo.

Ssp. **aestivalis** Sing. (type subspecies), ssp. nov.

Pileus "ochraceous buff" and "ochraceous tawny," or "cinnamon buff" and "clay color," or just "cinnamon buff," viscid, glabrous, smooth, naked, sometimes marbled in these colors, subconic or convex-subumbonate, or eventually with flattened center, 16–40 mm. broad. — *Hymenophore* "ochraceous buff" to "colonial buff" towards the margin, more rarely all over, with "capucine orange" spots, or between "orange buff" and "light orange yellow" tending to "yellow ocher" when maturing, or near "honey

yellow" when mature, adnate with a more or less pronounced decurrent tooth; tubes about 4 mm. long; pores concolorous, irregular, some radially elongate and 0.5–1.0 mm. wide in radial direction but never wider than 0.5 mm. transversely. — *Stipe* brownish white to white, then sordid grayish white, or assuming yellowish or pale orange yellow hues, finally sometimes darkening to "hair brown," glandulose, with the dots being all equally large or larger above the annulus (and then more scattered than below), brownish becoming badious, tawny, or vinaceous brown, inside solid, equal or tapering downward, 23–40 x 4–7 mm.; mycelium salmon color; veil connecting the margin with the apex of the stipe and running down the stipe, initially white near the stipe and more glutinous-hyaline near the margin, disrupted in this latter zone, the inner, lower portion forming an annulus which sheathes the stipe and has a strong tendency to become inversely infundibuliform (wider below), becoming sordid-white and then gray on maturing, more rarely with an olivaceous shade, viscid when wet (the covering gluten colorless), as high as broad or slightly reflexed-horizontal. — *Context* marbled "orange buff" and "light buff," unchanging, soft and somewhat watery; odor as in *S. punctipes* (agreeable), or none; taste not significant.

Spores 7.8–9.8 x 2.7–3.2 μ, most frequently 8.3–8.5 x 2.8–3 μ, pale melleous, smooth, ellipsoid-oblong to subcylindric; *basidia* 19–22 x 5.8–6.8 μ, 4-spored; *cystidia* 40–68 x 6.5–10.3 μ, strongly to moderately strongly incrusted, mostly elongate-clavate to broadly clavate, more rarely more fusoid or cylindric, or varying frequency even on the pores; *trama* truly bilateral; *pellicle* an "ixotrichodermium"; *dots* of the surface of the stipe consisting not only of the ordinary dermatocystidia of the *Suillus*-type but also of hyaline structures recalling the scales of *Leccinum* (*Krombholzia*) showing parallel, multi-septate hyphae terminating in a palisade of sterile, large basidium-like bodies (dermatopseudoparaphyses), and cystidia-like bodies (dermatocystidia of the *Leccinum*-type, *i.e.* rather small, hyaline, ampullaceous with narrowed bases); all *hyphae* without clamp connections.

Chemical reactions: **KOH** on surface of pileus "bone brown"; on pores dark dull lilaceous; on context of pileus "dark purple drab"; on context of stipe "dull Indian purple" or "deep purplish vinaceous"; on glandulae dark lilac. — **NH_3** on surface and context of pileus and on pores little or slow reaction, especially in young specimens; on cortex of stipe "vinaceous rufous" when quite mature. — **NH_4OH** on surface of pileus "cinnamon drab"; on context of pileus "cinnamon drab" or indeterminably darkening; on pores and tubes lilaceous pink, becoming drab, old specimens "vinaceous rufous" becoming "testaceous"; on context of stipe lilaceous pink, in age slowly to "dark vinaceous brown," middle portion more date brown. — **$FeSO_4$** very deep olive to black.

Habitat: On the naked or mossy ground and on mossy trunks in hammocks (low and high as well), more rarely in flatwoods and scrub, always in the neighborhood of either *Pinus palustris* or *P. taeda* though occasionally as far as 11 m. from the nearest pine tree, scattered or in small groups,

fruiting from May to September in north Florida, in central Florida until October.

Distribution: North and central Florida.

Material studied: **Fla.** Highlands Co., Highlands Hammock State Park, *R. Singer, F 478, F 478 a, etc.* (the **type** is *F 478*) (FH); Lake Co., Eustis, *R. Thaxter* (det. Singer) (FH); Levy Co., Gulf Hammock, *W. A. Murrill, F 18751* (FLAS); Alachua Co., Gainesville, *R. Singer, F 2164* (FH); near Dayville, *R. Singer, F 3035* (FH); Tung oil-mill on Newberry Road, *W. A. Murrill, F 17882* (FLAS); there were notes by W. A. Murrill at FLAS indicating the occurrence of what must be this form in Columbia Co.

Ssp. **hiemalis** Sing. ssp. nov.

Pileus between "wood brown" and "tawny olive" or "sayal brown" when young, later "ochraceous orange" and "pinkish buff" or "clay color" mixed with "sayal brown" and "bister," glabrous, smooth, naked, pulvinate, then convex with slightly depressed center, 50–63 mm. broad. — *Hymenophore* "antimony yellow" to "yellow ocher," or "primuline yellow" to "aniline yellow" with a shade of "honey yellow" to "olive ocher" when old, adnate, decurrent or more or less shallowly sinuate with a slight decurrent tooth, or plainly adnate; tubes 7–8 mm. long; pores concolorous or with some glands of the same color as these of the stipe, small (up to 0.5 mm. in diameter) with some larger ones intermixed (up to 1 mm.), not quite round; spore print between "ochraceous tawny" and "Isabella color." — *Stipe* pallid or whitish, becoming "light cinnamon drab," on the base "light salmon orange," eventually often with sordid shades or yellow portions, glandulose because of scattered to crowded glandular dots above and below the annulus which are concolorous with the pileus or paler, later becoming tawny or black (more often black), equal, solid, 30–35–(60) x 9–11–(13) mm.; mycelium salmon color; veil pallid, later becoming "citrin drab" to "deep olive" or gray, or some of these colors combined, or concolorous with the pileus, ruptured along a circular line near the apical surface of the stipe, and thus leaving an annular sheath on the stipe; annulus having the shape of a broad sheathing belt on the upper half of the stipe, tending to separate from the surface of the stipe at its lower white marginal rim, the outer (marginal) portion of the veil less persistent, eventually even the annulus which is fibrillose-membranaceous, and viscid to glutinous on its surface, collapsing or sliding downward, becoming yellow after freezing. — *Context* marbled "zinc orange" and "pinkish buff," or "buff yellow" near the surface of the pileus and sometimes also near the tubes, unchanging; odor like that of *S. punctipes* (agreeable), or none; taste mild or very slightly acid.

Spores 7.5–9.8–(12.3) x 2.7–3.5–(5) μ, ellipsoid-oblong to cylindric, smooth, pale melleous; *basidia* 20–26 x 6–7 μ, 4-spored; *cystidia* 34–90 x 4.7–11 μ, with castaneous or melleous incrustations, elongately clavate, not very numerous except at certain spots; *trama* and *pellicle* as in *ssp. aestivalis.*

Chemical reactions: **KOH** on surface of pileus plumbeous-gray; same reaction on tubes and context. — **NH_3** on surface of pileus almost negative;

on pores quickly "carrot red," then "vinaceous rufous," sometimes even "Hay's russet"; on context "carrot red" to "vinaceous rufous," sometimes even "Hay's russet," sometimes bright and lasting pinkish red in the base. — **NH_4OH** on surface of pileus slowly as with KOH; on pores as with NH_3, then slowly as with KOH; on context as on pores. — **H_2SO_4** on context deep reddish brown, subferruginous. — **$FeSO_4$** on context very deep olive to black (a very sensitive reaction).

Habitat: On soil under *Pinus palustris*, *P. taeda*, and *P. australis*, fruiting in Florida from October (north Florida) or November to January, farther north apparently during the fall months.

Distribution: From North Carolina to Florida. In Florida rather frequent in the north and probably also occurring in central Florida.

Material studied: **Fla.** Alachua Co., Gainesville, December and January 1942–1943, *R. Singer, F 1666* (**type**), *F 1666 a* (FH); Sugarfoot Hammock, January 1943 *R. Singer, F 1666 b* (FH); Orange Heights, November 1938, *W. A. Murrill, F 19400* (FLAS); Gainesville, *W. A. Murrill, 8778*; from schedulae (with the specimens removed) at FLAS by W. A. Murrill, it would seem that ssp. *hiemalis* also occurs in Marion Co.

The chemical differences of these two subspecies are similar to those between winter (below freezing) collections and summer collections of *Suilli* in general. The carrot red with ammonia is a reaction due to low temperatures, but there is, besides, a more purple reaction with alkali in the summer form. This and a slight difference in the color of the pileus are, in addition to the relative length of the stipe, the main distinguishing characters in all three cases of genuine or spurious seasonal dimorphism in *Suillus*. Despite careful and prolonged observation during two growing seasons, we were unable to ever find any alternation of summer and winter fruiting bodies at the same station, and, moreover, such an alternation could not even be considered possible during the time of our observation since the fruiting bodies of the summer form failed to show up even in the neighborhood of the places where the winter form had been collected. It must therefore be assumed that there exist, in this species, two parallel races, each adapted to one of the two different growing seasons of northern and central Florida. This biformity may have developed up to this point from a start similar to that found in *Flammulina velutipes* (Curt. *ex* Fr.) Karst. [*Myxocollybia velutipes* (Curtis *ex* Fr.) Sing.] whose seasonally dimorphous forms may be a more primitive stage of differentiation than what we have observed in *S. cothurnatus*. This is the first time that anything like the classical seasonally dimorphous races of R. Wettstein has been discovered in fungi.

It seems that Atkinson's *Boletus luteus* belongs partly to *S. subluteus*, and partly (*fig. 169*) to what in North Carolina takes the place of the winter form of *S. cothurnatus*. It may also be suspected that *S. cothurnatus*, together with similar forms, is hiding in Coker and Beers' description of *Boletus luteus*. Parts of the description and likewise their *pl. 5, fig. 2–3* suggest *S. cothurnatus*. I do not know whether in the Carolinas, so much farther north, with the biseasonal aspect of the mycoflora apparently in-

comparable with what is observed in Florida, or at least showing it in a much lesser degree, the distinction between ssp. *aestivalis* and ssp. *hiemalis* holds. It is quite possible that in another region another race occurs that shows less seasonal adaptation. It would be interesting to investigate further these things now that the distinction of *S. cothurnatus* from *S. luteus* has ceased to be a problem.

S. cothurnatus differs from *S. luteus* in having the whole context of an entirely different color. The difference is striking for anyone who knows the true *S. luteus*. Seasonal dimorphism has not been observed and obviously does not occur in *S. luteus*. Some smaller differences may be added but the easiest way to identify *S. cothurnatus* in the field is by the warm yellow context. I suspect that the forms associated with the series *Australes* of *Pinus* are always *S. cothurnatus*, and those associated with the pines of the series *Lariciones* are always *S. luteus*.

As for *S. subluteus*, commonly found under pines of the section *Cembra*, it is decidedly different from both *S. cothurnatus* and *S. luteus*. It is true that the glandulae of *S. luteus* are mostly supra-annular though occasionally also showing below the annulus, while *S. subluteus* and *S. cothurnatus* always have them both above and below the annulus, and more distinct at that. However, there is no need to stress this point since the main differences between all these species lie elsewhere. *S. subluteus* differs from *S. luteus* much more evidently in its more elongate stipe, its less distant veil, and its different colors. *S. subluteus* differs from *S. cothurnatus* in the shape of the annulus and the colors.

S. cothurnatus is edible, and as good as *S. luteus* though rarely abundant enough to be of much use.

9. **Suillus brevipes** (Peck) Kuntze, Rev. Gen. Plant. **3**[2]:535. 1898.

Boletus brevipes Peck, Ann. Rep. N.Y. State Mus. **38**:110. 1885.
Boletus viscosus Frost, Bull. Buffalo Soc. Nat. Sci. **2**:101. 1874.
Boletus pseudogranulatus Murr., Bull. Torr. Bot. Club **67**:63. 1940 (a variety).

Var. **typicus.**

Pileus in all colors occurring in *S. luteus*, viz. "fawn color," "Mikado brown," after cold rainy weather between "Sanford's brown" and "Mars orange" in some specimens, exposed portions soon bleaching to "cartridge buff," "cream buff," "chamois," "honey yellow," sometimes discolored to an indescribable drab (near "olive buff" or "deep olive buff"), often marbled in all these colors, or some of them, occasionally yellow showing through in frost-bitten specimens, with entire, rarely rimosely cracking, smooth, viscid pellicle which is easily entirely removable, glutinous in wet weather, naked and glabrous except for occasional appressed or fimbriate fibrils of the veil on the margin, often with narrowly sterile margin, with a dirty whitish covering all over in some of the veiled specimens, especially as long as they are young and grow in dry weather, convex, often somewhat depressed in the center, 40–105 mm. broad. — *Hymenophore* "baryta yellow," "straw yellow," "lemon yellow," eventually somewhat duller, adnate

or mostly very slightly sinuate near the stipe; tubes 4–6 mm. long, i.e. rather short; pores concolorous, finally becoming "deep colonial buff," small but of varying diameter, in average (2)–3 pores to a mm.; spore print between "ochraceous tawny" and "Isabella color." — *Stipe* white, becoming yellowish at apex and brownish at base when old, but always pure white all over when young, without glandulae, or often with very small concolorous or pallid to pale brown glandulae which are not readily visible to the naked eye and are limited to the upper third of the stipe, or sometimes to the middle portion, better visible on well-dried stipes, non-viscid, solid, cylindric or slightly ventricose, remarkably short, sometimes even shorter than thick, 8–30 x 10–24 mm.; veil inconstant and not persistent, never forming a true annulus and only rarely forming a narrow belt, but often found on the margin of the pileus, membranaceous-fibrillose, sordid drab to white or with these colors mixed, more distinctly visible in dry and warm weather. — *Context* pure and uniformly white in both pileus and stipe, later yellowish above the tubes, and in very old, especially frozen material, sometimes yellowish in most parts (reaching "yellow chrome"), soft and watery as in *S. luteus*; odor agreeable as in *S. luteus*, or none; taste mild and slightly acidulous.

Spores (6.7)–7.5–8.8–(11) x 2.7–(3) μ, pale melleous, subellipsoid-subfusoid to cylindric (more so from the profile), smooth, thin-walled; *basidia* 20–21 x 6–7 μ, 4-spored; *cystidia* 55–83 x 8–10.3 μ, numerous, strongly incrusted, only a few of them non-incrusted or little incrusted, clavate with a capitate apex, rarely subfusoid-subcylindric; *trama* truly bilateral; *pellicle* of the pileus consisting of an "ixotrichodermium"; stipe without dermatocystidia or with scattered ones but in those specimens with more or less distinct glandulae in dried condition, the latter are composed of fascicles of hymenium consisting of strongly incrusted clavate-capitate, or subfusoid, or clavate dermatocystidia, 27–67 x 8–14 μ.

Chemical reactions: **KOH** on surface of pileus, dark gray; on tubes, sordid gray to nearly "bone brown"; on white context, dirty lilac becoming more grayish and in older drier material lilac for a very long time and then drab; in the yellow context of the stipe, dirty lilac, becoming more grayish. — **NH_4OH** on the paler portions of the pellicle causing them to become darker, then "purplish vinaceous," darker portions slowly "purplish vinaceous"; on context of older drier material, lilac then blue. — **NH_3** on surface of pileus reacting as with NH_4OH; on white context, "alizarin pink" for a moment, then vanishing, in older and drier pilei "salmon pink"; on yellow portions of the context of the pileus, between "cadmium orange" and "orange rufous," becoming bluish-caesious; on tubes, "ochraceous salmon," in older drier material reacting as with the yellow context. — **H_2SO_4** on the pellicle nil; on the pores, rusty ochraceous. — **Methyl-paramidophenol** very pale grayish hyaline (almost negative), except for the zone above the tubes and across the apex of the stipe where a slow yellow reaction takes place, not becoming violet anywhere.

Habitat: In pine woods, under *Pinus taeda, P. australis* (in Florida; in

other regions with related species of pines), also in mixed woods under 2-needle-pines, gregarious, usually in large groups or rows; fruiting in Florida from October to May, farther north in fall.

Distribution: North America, most common in the southeastern states. In Florida mainly in the northern part, not observed in south Florida.

Material studied: **Fla.** Alachua Co., Gainesville, Dec.–Jan. 1942–43, *R. Singer, F 1646, F 1646 b, F 2044* (FH); *W. A. Murrill, F 18440 (Boletus granulatus)* (FLAS). — **N.Y.** Karner (**authentic** material of *Boletus viscosus* Frost) (NYS); also several collections of Peck (**authentic** material of *Boletus brevipes*) (NYS).

This species is very closely related to *S. granulatus* ssp. *Snellii*, and since material of this latter was the main source of information on *S. granulatus* in general available to Murrill, it is not surprising that he considered it as a synonym in *North American Flora*. However, when studied in Florida where *S. granulatus* ssp. *Snellii* and similar fungi except *S. brevipes* do not occur at all, the species seems to be quite constant in its characteristic features except for such definite varieties with longer or swollen stipe as shall be described below. These varieties show a limited though undeniable convergence toward *S. albidipes*. If it were not for some minor characters and the mycorrhizal association, these uncommon atypical forms of *S. brevipes* would seem to be indistinguishable from *S. albidipes*. This may lead to confusion in places where *S. brevipes*, *S. albidipes*, and *S. granulatus* ssp. *Snellii* occur simultaneously, and where mixed stands of conifers make the separation difficult. It is very probable that these seemingly convergent forms actually mark the evolutional starting point of the American group of species gravitating around *S. granulatus*. *S. brevipes*, then, would mark the stage of complete adaptation to 2-needle pines. Since *S. brevipes* and its varieties in Florida form a very definite group within the subsection *Angustiporini*, I do not combine it with *S. granulatus* as a subspecies, inasmuch as others may feel that not only *S. albidipes* and *S. brevipes* but also *S. granulatus* ssp. *Snellii* and ssp. *leptopus* (*S. Bellinii*) should all be treated as autonomous species, rather than as subspecies of *S. granulatus*. While no argument *pro* or *contra* is offered here, the author thinks it necessary to call the attention of the specialists to this very interesting though complicated problem in order to get more new facts from different regions. The necessity to do so will arise still more urgently when western collections are compared with material gathered in the East and South.

S. brevipes is, as also has been stated by Peck and others, a good edible species, providing large quantities of palatable food during the winter months for the few people who know it.

Var. **aestivalis** Sing. var. nov.

A typo differt stipite elongato et statura paulum minore. Sub *Pinibus taedis* in Florida Americae Borealis Junio–Augusto mensibus.

Differs by a longer stipe than the type variety, and thus approaches *S. albidipes* but easily distinguished by the smaller size, the almost non-

decurrent tubes, the white interior that becomes yellow with age (nowhere brownish red), and the mycorrhizal association with *Pinus taeda*. It is known only from the type locality in Gainesville, Alachua Co. Fla. where it grows infrequently in small groups. The microscopical and chemical characters are the same as in the type variety. Because of the longer stipe it corresponds to the seasonal dimorphous subspecies of *S. cothurnatus* and *S. hirtellus* but the difference seems to be less pronounced and less constant. We are still not entirely convinced that this is a summer race rather than a mere summer-adaptation alternating, on the same mycelium, with the winter fruiting bodies. As long as no more observations can be had, we shall have to term this a *varietas* in our sense (as a temporary nomenclatoral status).

Var. **pseudogranulatus** (Murr.) Sing. comb. nov.

Boletus pseudogranulatus Murr., Bull. Torr. Bot. Club **67**:63. 1940.

Pileus "avellaneous" with a slight drab or cinnamon tinge, or rather tending toward clay color or umber, with paler places, viscid when wet, moderately shining when dry, smooth and glabrous, but sometimes with easily separable inconspicuous sordid patches of a thin membranaceous deep dirty-gray veil on the margin which is very acute, strongly convex and usually remaining so in the middle while the marginal part becomes flattened, or becoming subplane all over, thick even for a bolete, 60–110 mm. broad. — *Hymenophore* between "empire yellow" and "picric yellow," somewhat irregular but not gyrose-merulioid, not quite readily separable from the context, adnate-decurrent, or decurrent and mostly continuing on the apex of the stipe as an indistinct narrow reticulated belt; tubes 4.5 mm. long in quite adult specimens, i.e. rather short; pores concolorous, small (about 2 to a mm.). — *Stipe* initially white but soon becoming "lemon chrome" and "light cadmium" at places and eventually entirely yellow, smooth or rarely very indistinctly rugulose near the base, glabrous or with very small, not very distinct pallid to blackish glandular dots as in *S. brevipes* var. *typicus* but often, at least on one side of the stipe, connected by very fine lines, and thus forming a network that may extend over a large portion of the stipe, or be confined to the apex, avelate or with a narrow, indistinct, soon disappearing annular belt which is deep dirty-gray, with swollen ventricose lower half which may again be tapering toward the very base, 30–60 x 26–40 mm. (near the middle or base), 17–24 mm. at the apex, solid; mycelium yellowish or yellowish white. — *Context* white, yellow in the peripheral parts of the stipe and in the base, often also toward the tubes, very thick and solid-fleshy in the pileus except for the swollen part of the stipe where it may be soft and spongy; odor as in *S. luteus*; taste mild or slightly acidulous.

Spores (6.7)–7.5–9.5–(11) x 2.7–(3.3) μ, in shape and color similar to those of var. *typicus*; *basidia* as in var. *typicus*; *cystidia* 30–65 x 7.5–10.5 μ, numerous, strongly fulvous-castaneous or melleous from a resinous in-

crustation, oval or clavate above, more rarely fusoid or ampullaceous, with thin lower part.

Chemical reactions: **KOH** on context and surface of pileus, drab; on context of stipe, grayish green becoming black; on pores, deep grayish brown. — **NH_3** and **NH_4OH** on the surface of the pileus, slate gray; on context of pileus, rosy pinkish then becoming slate gray; on pores and tubes, "vinaceous rufous," then becoming grayish green, and same colors seen in the cortex of the stipe. — **H_2SO_4** on the tubes a similar reaction as with NH_3. — **Aniline** negative. — **Formol** negative. **Methylparamidophenol** negative. Note: these reactions were obtained with quite mature fruiting bodies in cold weather.

Habitat: In dense hammocks, under or near *Pinus palustris*, *P. taeda*, or *P. australis*, solitary, fruiting from October to April.

Distribution: Known only from Alachua Co., Fla.

Material studied: **Fla. Type** (FLAS); Gainesville, *R. Singer, F 1704* (FH); *F 1877* (FH).

This species has not a distinctly elongate but rather a ventricose or inversely claviform stipe. It is much more variable than may be assumed from Murrill's description. The thicker stipe with decurrent tubes distinguishes it from the type. The reticulation stressed by Murrill is an inconstant character. In only one carpophore out of all I have seen, do I find a reticulation worth recording. The veil cannot serve as a distinguishing character since the same kind of veil is observed also in a certain percentage of fruiting bodies of the type variety, but these fruiting bodies do not differ from the avelate ones in any other way. Var. *pseudogranulatus* seems to be an aberration due to peculiarities of the habitat. It occurs in moister soil of hammocks where the carpophores are less exposed to the rain. Whether this is just a *forma*, or a constant race, cannot be decided immediately.

EXTRALIMITAL SPECIES

Suillus subluteus (Peck) Snell *apud* Slipp & Snell, Lloydia **7**:34. 1944.
Boletus subluteus Peck, Bull. N.Y. State Mus. **1**:62. 1887.

Since this species has been confused with *S. luteus* as well as with the Floridan *S. cothurnatus*, I think it is necessary to give a complete description of *S. subluteus*, based on collections made by this writer in the Huntington Wild Life Forest, Newcomb, N. Y. (FH, NYS) which were compared with the type of *S. subluteus* (NYS).

Pileus more or less "chamois" (colored somewhat like the European *S. flavidus*), but sometimes more reddish than "chamois," sometimes more olive, glutinous when wet, often slightly squamulose with indistinct, appressed squamulae, convex, 57–63 mm. broad. — *Hymenophore* various shades of yellow with an olivaceous shade in age, adnate to slightly decurrent; tubes medium long; pores decidedly smaller than 1 mm. in diameter, only in large, old specimens reaching 1 mm., somewhat angular, be-

coming somewhat sordid on pressure, somewhat glandular-dotted; spore print between "ochraceous tawny" and "Isabella color." — *Stipe* concolorous with the pores, more pallid near the base, beset with light brown, later, especially below, often with dark brown to almost black glandulae above and below the annulus, with watery, colorless, or watery-yellow droplets distilled from the glandular dots on the pores next to the stipe and on the apex of the stipe, annulate, solid, equal or slightly thickened downward, slender as compared with the usual shape of the stipes of *S. luteus*, about 60 x 9 mm.; mycelium sordid-grayish; annulus pallid, appressed or somewhat distant in young specimens, not conspicuously broad-sheathing, and soon collapsing into a mere slimy belt, apical but sometimes sliding down to the middle, membranaceous but very glutinous when wet and eventually sordid or concolorous with the remaining surface of the stipe. — *Context* white, very slightly and slowly turning sordid when exposed, in the stipe more yellowish when bruised; odor like that of *S. punctipes* but weaker; taste mild, slightly acidulous.

Spores 9–10.7–(11) x 3.3–3.8 μ, mostly 9.5 x 3.5 μ, rather pale melleous, smooth; *cystidia* 38–120 x 5.5–7.5 μ, cylindric, obtuse at the apex, or clavate, almost constantly incrusted with a brown, resinous crust or granules, *glandular dots* consisting exclusively of (20)–70–125 x (3.5)–7–9.5 μ large, narrowly clavate, rarely fusoid and then often 6.5 μ broad, incrusted dermatocystidia; *hyphae* without clamp connections.

Chemical reactions: **KOH** on surface of pileus, dark sordid gray; on pores, dark reddish brown. — **NH_3** and **NH_4OH** on surface of pileus, reddish brown; **NH_3** on the context of the pileus, salmon pink; **NH_4OH** on the context of the pileus, blue; on the pores, dark gray. — **Methylparamidophenol** negative.

Habitat: With *Pinus strobus* (and probably with other 5-needle pines) in woods, often together with *S. granulatus* ssp. *Snellii*.

Distribution: Eastern States of the U.S.A., not reaching Florida in the south; the western limits of the species have not been established.

The spores which are larger than those of *S. cothurnatus* and *S. luteus*, provide a good character to distinguish poor specimens or dried material of *S. subluteus* from *S. luteus* and *S. cothurnatus*. The chemical characters also seem to be different in these species (see also observations under *S. cothurnatus*).

Suillus luteus (L. *ex* Fr.) S. F. Gray, Nat. Arr. Brit. Pl. **1**:646. 1821.
Boletus luteus Linné *ex* Fr., Syst. Mycol. **1**:386. 1821.
Ixocomus luteus Quél., Flor. Mycol. p. 414. 1888.
Cricunopus luteus Karst., Rev. Mycol. **3**:16. 1881.

The description and figures given by Kallenbach, Pilze Mitteleuropas **1**(8):45, *pl. 19*. 1928, should be compared with the foregoing descriptions of *S. subluteus* and *S. cothurnatus*. In order to make this comparison complete, I want to add some data on *S. luteus*, either not contained in Kallenbach's account or mentioned there in a different manner:

Spores in a very fresh print "ochraceous tawny," under the microscope (6.8)–7.5–9–(10) x 2.8–3.3 μ, pale melleous, smooth, ellipsoid-subfusiform to cylindric. — **KOH** on surface and context of pileus, "slate olive" to dark dirty-gray; on the context, occasionally reddish at first; on the pores, "bone brown," or reddish to brownish red and eventually becoming "bone brown," at times passing through a lilac phase before becoming brown. — **NH_3** on surface of pileus, negative to very pale pink; on context of pileus (where yellow), "salmon buff," eventually with lilac shades; on pores and tubes, pale reddish to brownish pink or orange-tawny. — **NH_4OH** on surface of pileus, little reaction, or slowly dark gray; on context of pileus, "slate olive" (where it had been yellow). — **H_2SO_4** on the yellow context of the pileus, "primulin yellow"; on pores, "ochraceous orange"; on surface of pileus, negative.

Habitat: Under *Pinus silvestris*, *P. montana*, *P. nigra*, *P. resinosa* (also reported with *P. pinaster* by Kallenbach but this seems doubtful; in experiments, forming mycorrhiza even with *Picea* and *Larix*), i.e. in nature always with pines of the section *Lariciones*.

Due to the erroneous identification of *S. subluteus* and *S. cothurnatus* as *S. luteus*, the author was for a while doubtful as to whether the true *S. luteus* occurs in America at all. However, a large collection of excellent fresh material growing under *Pinus resinosa* (coll. P. Gast, September 1944 in the Harvard Forest, Petersham, Mass.) proved the fact that a species entirely identical with the European *S. luteus* occurs in this country. It is now difficult to say whether this was originally imported with *Pinus silvestris* and then spread, or — more probably — if it is native in North America. It does not reach Florida.

Suillus placidus (Bon.) Sing., Farlowia **2**:42–43. 1945.

Boletus placidus Bon., Mohl's Botan. Zeitschr. **19**:204. 1861.
Boletus albus Peck, Rep. N.Y. State Cab. **23**:130. 1873.[12]

As for the discussion of this species see Singer, *l.c.* 1938, and *l.c.* 1945. The types of Peck's have been compared with material collected by this writer in New York State. *B. albus* and *B. placidus* are most certainly identical.

I do not think that *S. placidus* occurs in Florida. I have not collected white *Suilli* in Florida at all. W. A. Murrill collected a specimen of what he calls *Boletus granulatus* (in his sense a collective species), adding, on the label (*F 16407*, FLAS) "white form." It was more slender-stemmed than the usual *S. brevipes* but this would not mean much since it was collected in summer when the slender-stemmed summer form of *S. brevipes* is found. The glandulae are not too clearly visible. Schematically, this specimen would have to be determined as *S. placidus* but it may also be a white form of *S. brevipes* var. *aestivalis*, or an exannulate form of **S. acidus** (Peck) comb. nov. (*Boletus acidus* Peck).

[12] For a complete list of synonyms see Singer, Rev. de Mycol. **3**:48. 1938.

Suillus granulatus (L. *ex* Fr.) Kuntze, Rev. Gen. Plant. 3²:535. 1898.

The European type (ssp. *typicus*), the American (ssp. *Snellii*), and the Mediterranean (ssp. *leptopus*) race have been discussed in Farlowia **2**:41–45. 1945. When studying the western collections of *Suilli*, the author came across an abundant collection of what is easily recognized as *S. granulatus*, but the determination of the subspecies causes difficulties. I cannot, without extensive study of fresh material, indicate whether this Idaho subspecies is identical with any known subspecies or represents an allied subspecies, but it probably is not ssp. *Snellii*. This partly explains the fact that Slipp and Snell find slight modifications in size and veil of Idaho specimens depending on whether the plants occur with *Pinus monticola* (sect. *Cembrae*) or *P. contorta*. The specimen shown in the illustration (Lloydia **7**:41, *pl. 4, fig. A*. 1944) would suggest *S. brevipes* by its habit but it probably is the *Pinus contorta* form of *S. granulatus*. Good *separate* descriptions of these collections may help solve this problem.

Suillus albidipes (Peck) Sing., Farlowia **2**:45. 1945.

Boletus granulatus var. *albidipes* Peck, Rep. N.Y. State Mus. **54**(1):168. 1901.
Boletus albidipes Peck, Rep. N.Y. State Mus. **65**:22. 1912.

This little known species is about intermediate between *S. brevipes* and *S. granulatus* ssp. *Snellii*. Since the summer form of *S. brevipes* or *S. brevipes* var. *pseudogranulatus* may be confused with *S. albidipes*, and also because of the lack of adequate descriptions of *S. albidipes*, we include here a description of it, obtained from material collected by this writer near Newcomb, N. Y. (FH) and compared with the type (NYS).

Pileus "cinnamon rufous," somewhat deeper colored when young, slightly tending toward "zinc orange," with the yellow of the flesh showing through the pellicle of very old and watery specimens, darker and paler spots sometimes tessellately alternating, usually slightly rivulose under the viscose surface, or areolate when old, pallescent from the middle outward in many specimens, the margin in very many of the young specimens with a white or pallid velutinous or fibrillose-tomentose band from an indistinct veil, convex, obtuse, 40–105 mm. broad. — *Hymenophore* flesh-whitish, then yellow as in *S. granulatus* ssp. *Snellii*, adnate-decurrent to strongly decurrent; tubes as long and the concolorous pores as wide as in *S. granulatus* ssp. *Snellii*; spore print between "ochraceous tawny" and "Isabella color" (nearer to the latter). — *Stipe* pure white becoming somewhat lemon-yellow in the upper fourth to two thirds when old or in cold weather, usually stained with tan color in the middle, yellowish fibrillose at the base, indistinctly glandulose all over or with small scattered white, later pale brown glandulae at the apex (upper fourth to half), otherwise glabrous and smooth, non-viscid, solid, often becoming stuffed, cylindric or clavate (tapering upward), or tapering downward, or ventricose, straight or curved, 50–115 x 8–28 mm.; mycelium white. — *Context* white, later reddish or brownish (reminding one of *Amanita rubescens* in this regard) in the stipe, especially in the middle of the stipe, in the apex of the stipe rather becoming

bright lemon yellow than reddish, and also somewhat lemon yellow toward the tubes; odor as in *S. luteus*, but very slight; taste mild to slightly acidulous.

Spores 6.8–9.2 x 2.7–3.2 μ, mostly 7.8–8.5 x 3 μ, pale melleous, smooth, cylindric, fusoid-cylindric, or fusoid-ellipsoid; *basidia* about 20 x 5 μ, 4-spored; *cystidia* either hyaline and scattered, or more or less incrusted and in fascicles or scattered, cylindric-clavate or broadly clavate, their wall slightly thicker than the wall of the basidia, 42–72 x 6.5–11.5 μ; *trama* and *pellicle* as well as glandulae as in *S. brevipes*.

Chemical reactions: **KOH** on surface and context of pileus, dirty grayish, *not* violet; on pores, deep dirty fuscous, becoming almost black, blackish fuscous. — **NH_3** and **NH_4OH** on surface of pileus, more grayish; on context of pileus, pink then lilac ("pale brownish vinaceous"); on context of stipe, negative, only lemon-yellow places becoming deep orange-brown-rufous; on tubes, orange-ferruginous.

Habitat: In open coniferous and mixed woods under or near *Pinus strobus* (sect. *Cembrae*), but occasionally, in regions where white pine is common, also growing with *Abies balsamea*.

Distribution: From Massachusetts to New York, south apparently to North Carolina, but western limits unknown.

This differs from *S. brevipes* in the elongate stipe, the reddish tones in the context, and the habitat; from *S. granulatus* in the reduced glandulosity of the stipe, a slight difference in the chemical reactions, and the reddish tones in the context. It may eventually be reduced to the status of a subspecies of the latter.

Subsect. **Hirtellini** Sing. subsect. nov.

Sporis in cumulo saturate brunneo-olivaceis; poris circa 1 mm. amplis, interdum paulum amplioribus vel angustioribus; carne pilei ammoniaci ope vix vel tardive reagente (grisente vel violascente); pileo innate fibrilloso in juventute vel fibrilloso-squamuloso-hirtello.

Characters of the subsection: see key (p. 259) and the above Latin diagnosis. Type species *Suillus hirtellus* (Peck) Kuntze (*Boletus hirtellus* Peck).

KEY TO THE SPECIES

A. Context unchanging or at least not becoming blue on exposure; stipe only very slightly and gradually tapering toward the apex or almost perfectly equal.

B. Stipe strongly thickened toward the base; pores brownish to brownish-olive, never clear yellow; glandulae crowded, often running into each other and making the stipe sticky; numerous non-incrusted fusoid cystidia present on the pores; spores (7.8)–8.8–11.5 x 3–3.7 μ; color of the pileus often about "Mars yellow"; mycelium white; ammonia (also vapors) on the surface of the pileus definitely negative. *S. punctipes*

B. Stipe slightly if at all thickened toward the base; pores from the early immature to the final overmature stage showing a clear yellow, or more pinkish-ocher in youth and more yellowish-olive in age; glandulae though distinct and numerous not really crowded and not forming sticky patches; non-

incrusted cystidia infrequent, fusoid cystidia exceptional, or wanting; spores (6.8)–7.5–10.2 x 3–3.5 μ; color of the pileus never "Mars yellow"; mycelium not always white; ammonia (vapors) on the center of the pileus after long exposure "Persian lilac," on the margin "acajou red"; ammonia water lilac, then carmine, then amethyst color around an eventually "cinnamon buff" spot. 10. *S. hirtellus*

A. Context more or less bluing; stipe more or less thickened toward the base.

C. Pileus and stipe golden yellow, then sulphur yellow to yellowish cream; mycelium white, "in seral association in the *Thuja-Tsuga*-zone" in Idaho. *S. hirtellus var. mutans*

C. Pileus ocher brownish to orange brownish with darker squamulae; mycelium pink; in *Larix-Pinus-Picea*-stands of the northern slopes of the Altai Mts. associated with *Pinus sibirica*. *S. cembrae*

10. **Suillus hirtellus** (Peck) Kuntze, Rev. Gen. Plant. 3^2:535. 1898.

Boletus hirtellus Peck, Bull. N.Y. State Mus. **2**(8):94. 1889.
Ixocomus hirtellus Sing., Ann. Mycol. **40**:30. 1942.
Rostkovites hirtellus Murr., Mycologia **1**:14. 1909.
Boletus hirtellus var. *siccipes* Coker & Beers, Boletaceae, p. 83. 1943.

Ssp. **cheimonophilus** Sing. ssp. nov.

Mycelio plerumque manifeste albido, carpophoro majore, stipite breviore latitudine pilei, tubulis circum stipitem raro distincte depressis; sporis saepe elongatis, tenuibus, plus minusve cylindricis; forma hiemalis.

Pileus "barium yellow" to "pinard yellow" with subconcolorous or somewhat darker innate fibrils which form subappressed but hirtose squamulae on the disk, dry in dry weather, decidedly viscid in wet weather, occasionally showing a grayish band around the extreme margin (veil), convex, becoming subplane, 50–90 mm. broad. — *Hymenophore* "wax yellow" to "olive lake," adnate to slightly depressed, not decurrent; tubes moderately long; pores concolorous but often with some brownish glandulae, medium wide (around 1 mm. in diameter), not exuding drops unless diseased; spore print rather deep olive. — *Stipe* yellow, pallid toward the base, beset with numerous pale brown, then testaceous-chocolate, eventually blackish glandulae over its entire length, solid, equal or at least equal in its upper two thirds, and then the base slightly thickened and again acuminate below, 40–70 x 5–20 mm., mostly 45–60 x 5–20 mm.; veil none on the stipe; mycelium mostly whitish. — *Context* pale yellow, unchanging; odor none; taste mild.

Spores 8–13.5 x (2.5)–3–3.3–(3.7) μ, melleous, smooth, cylindric or subfusoid-cylindric, rarely subellipsoid with suprahilar depression, or without depression; *basidia* and *cystidia* as in ssp. *thermophilus*; *trama* and *glandulae* not studied.

Chemical reactions: **KOH** on surface of pileus and stipe and on the pores and context, "bay" but somewhat deeper. — **NH_3** and **NH_4OH** on surface of pileus, negative for a long time, then assuming a vinaceous hue, then "cinnamon buff"; on pores, more sordid grayish olive, then becoming deep olive gray with a cinnamon ring; on context, an undefinable grayish tinge, then becoming pallid sordid brown.

Habitat: On sandy soil under pines, in Florida under *Pinus palustris*, *P. australis*, and *P. taeda*, usually solitary, or in small groups, fruiting in Florida in December and January.

Distribution: Florida (if the northern form is included, it is distributed from New York to Florida with the western limits unknown).

Material studied: **Fla.** Alachua Co., Newnan's Lake, Jan. 30, 1943, *R. Singer, F 1772* (FH); Magnesia Springs, Jan. 5, 1941, *G. F. Weber, (indet.) F 19826* (FLAS).

Ssp. **thermophilus** Sing. ssp. nov. TEXT-FIGURE 1.

Mycelio plerumque manifeste roseolo; carpophoro minore; stipite longiore latitudine pilei; tubulis circum stipitem plerumque distincte depressis; sporis forma sua haud distinctis; forma aestivalis thermophila.

Pileus initially cinnamon, soon becoming "baryta yellow," somewhat "maize yellow" on the disc, then "Martius yellow" or "sulphur yellow," or "light Chalcedony yellow," subviscid, innately fibrillose and minutely hirtose, the margin initially covered with cobweb-like to woolly remnants of the veil which in the primordia continues into an indistinct, glutinous, hyaline veil that disappears before full maturity, convex, soon flat around the umbo, but sometimes without an umbo (subumbonate or obtuse), 38–58 mm. broad. — *Hymenophore* between "deep colonial buff" and "olive ocher," depressed around the stipe; tubes 5–8 mm. long; pores initially "capucine buff," then "ochraceous buff," then "barium yellow," then "light ochraceous buff," and eventually between "deep colonial buff" and "dark olive buff," or "sulphine yellow," small (2 to a mm.) to medium (7 to 5 mm. tangentially, or 4 to 5 mm. radially), up to 1 mm. in diameter; spore print deep olivaceous. — *Stipe* concolorous, the brightest portions about "primuline yellow," beset with glandular dots which are sparse to very numerous, initially white or cinnamon, later concolorous with the remaining surface of the stipe, or whitish, then becoming carmine red, brownish red or indefinitely remaining concolorous, the upper part of the stipe and also sometimes the pores guttulate (droplets consisting of a whitish, rarely avellaneous latex), entirely solid, cylindric (after having been thinner at the apex in very young stages) to subequal, or with a root-like tapering base, 50–60 x 6–9 mm.; mycelium mostly salmon color; veil none. — *Context* yellow, unchanging; odor none, or very slight, like that of *S. luteus*; taste mild.

Spores (6.8)–7.5–10.2 x 3–3.2 μ, brownish melleous, some pale melleous, smooth, fusoid to ellipsoid, in profile cylindric to fusoid; *basidia* 26 x 7 μ, 4-spored; *cystidia* 37–71 x 5.3–16 μ, with about 0.5 μ thick walls (the often strongly developed resinous incrustation not included), most of them colored because of the incrustation, few hyaline, elongate-clavate, in fascicles; *dermatocystidia* of the glandulae of the stipe of one type only, viz. the incrusted, clavate (*Suillus*-) type, 17–77 x 6–9.5 μ; hyphae without clamp connections.

Chemical reactions: **KOH** on surface of pileus, deep brownish yellow or lilaceous brown; on pores, dirty brown; on context, various shades of

brown. — **NH_3** little reaction immediately but if exposed long enough, the disc of the pileus becomes "Persian lilac," and the margin "acajou red"; on pores, slowly drab; on context, negative or similar to the reaction on the surface of the pileus. — **NH_4OH** on surface of pileus, lilac, then carmine, then amethyst color, then fading; on the context of the stipe, almost negative, or slowly sordid; in the base of the stipe, rapidly drab. — **$FeSO_4$** on the context, slowly olivaceous yellow.

Habitat: In mixed stands of low hammock and in flatwoods under *Pinus*

TEXT-FIGURE 1. *Suillus hirtellus* (Peck) Kuntze ssp. *thermophilus* Singer. Fresh specimens from Highlands Hammock State Park, Florida after prolonged exposure to ammonia vapors to bring out the hirtose character of the pileus. x ¾.

palustris in small groups, fruiting from June to September, or perhaps October.

Distribution: From Georgia to south Florida (not in the tropical zone).

Material studied: **Fla.** Highlands Co., Highlands Hammock State Park, Aug.–Sept. 1942, *R. Singer, F 543* (**type**) (FH); *F 543 a, F 543 b* (FH); Alachua Co., Gainesville, *W. A. Murrill,* (as *B. granulatus*) *F 16526* (FLAS). — **Ga.** Vicinity of Talullah Falls, north bank of river above bridge, Sept. 1901, *A. B. Seymour & W. L. Moss* (det. W. H. Snell as *B. hirtellus*) (FH); Fern Valley, Sept. 1901 (FH); Fern Brook and Bad Branch, Sept. 1901 (FH).

I am at present not in a position to decide whether the northern form, *i.e.* the type form, belongs to any of these subspecies or constitutes a subspecies by itself. From the specimens I have seen, and from the best descriptions available, I would guess that it belongs rather to ssp. *cheimo-*

nophilus. More phenological observations, however, will have to prove this point. It is possible that the northern form is unadapted to any special season and shows some distinguishing character or characters that would make it advisable to separate it as ssp. *typicus*.

We have examined authentic material of *Boletus hirtellus* var. *siccipes* Coker & Beers, *l.c.* The differences between this and the Albany specimens are so slight as to be considered negligible.

EXTRALIMITAL SPECIES

Suillus hirtellus var. **mutans** (Peck *ex* Snell) Snell *apud* Slipp & Snell, Lloydia **7**:23. 1944.

Boletus hirtellus var. *mutans* Peck *ex* Snell, Mycologia **33**:26. 1941.
Boletus tomentosus Kauffman, Pap. Mich. Acad. Sci., Arts & Lett. **1**:117. 1921, *non* Krombh. Nat. Abb. Schw. **5**, *pl. 36, fig. 19–20.* 1836 (year uncertain), *nom. nudum*; *nec Boletus tomentosus* Raddi *ex* Sacc. Syll. **23**:346. 1925.

I have seen only Henderson's specimens (NYS) of Peck's unpublished variety which may well be an autonomous species or a geographic race (subspecies) of *S. hirtellus*. If recognized as a species, it should be known under the specific epithet used by Kauffman, since the figures in Krombholz do not provide essential characters and do not give analyses as would be necessary to really understand this species. Art. 44 (3) of the International Rules is therefore not applicable in this case, and is, for that matter, very rarely applicable at all in groups where the color of the spores and their shape, the presence or absence of clamp-connections, the structure of the trama, the viscidity of the pileus or stipe etc. are essential characters while the characters shown in these early pictures are "essential" (if the meaning of the word is stressed) only if the painting is executed and reproduced so well as to leave no doubt about the identity of the fungus. This is not the case with *B. tomentosus* Krombh. The description given by that author later under another name, combines two tentative "new species" and is, consequently, useless as a descriptive basis for *B. tomentosus*. *B. tomentosus* Raddi is pre-Friesian, and was validated by Saccardo four years after Kauffman. The only way of ruling out Kauffman's species is by proving it to be a synonym (of *S. hirtellus* or a subdivision of it, or perhaps of *Rostkovites californica*), not a homonym.

Suillus cembrae (Sing.) Sing. comb. nov.

Ixocomus cembrae Sing., Rev. de Mycol. **3**:49. 1938.

Described from the Altai Mts. in Siberia, this is an independent species, close to *S. punctipes* (Peck) Sing.

Suillus punctipes (Peck) Sing. comb. nov.

Boletus punctipes Ann. Rep. N.Y. State Mus. **32**:32. 1880.
Ixocomus punctipes Sing., Ann. Mycol. **40**:30. 1942.

The data obtained through study of fresh and dried material in New York State show that this species, observed under *Pinus strobus* by this

author, has white mycelium (not pink as *S. cembrae*), and that the context remains unchanged when broken. This, coupled with the difference in the mycorrhiza-host, indicates that these specimens are different. The chemical reactions of the New York material were: **KOH** on surface of pileus, brown; on context of pileus, immediately sordid lilac, then lilaceous brown; **NH_3** on surface of context of all parts, negative; **NH_4OH** on surface of pileus, negative; on context of pileus, slowly pale and sordid lilaceous; **$FeSO_4$** on context of pileus, pale gray. — The spores are subfusoid-subelliptical in frontal view, subfusoid in profile, melleous, smooth, (7.8)–8.8–11.5 x 3–3.7 μ; basidia 20–28 x 6.5–7 μ, 4-spored; cystidia broadly clavate to mostly elongate-clavate, or fusoid, either non-incrusted or more or less strongly incrusted, very numerous, especially near the pores, the walls moderately (0.5 μ) thick, 30–70 x 4.5–10.5 μ, the incrusted ones more often clavate than fusoid and the non-incrusted ones more often fusoid. — This species is distributed in the northeastern States reaching south as far as North Carolina with the western limits unknown.

Sect. **Bovini** Sing., Rev. de Mycol. **3**:38. 1938.

Characters of the section: see key, p. 259. Type species: *S. bovinus* (L. *ex* Fr.) Kuntze, Rev. Gen. Plant. 3^2:535. 1898 belonging in subsect. *Euryporini* Sing. *l.c.*, p. 53. Another species, *S. variegatus* (Sw. *ex* Fr.) Kuntze, *l.c.* is the type of subsection *Stenosporini* Sing. *l.c.* None of these occurs in Florida, and even their occurrence in North America is, though claimed, not quite certain.

Sect. **Piperati** Sing., Rev. de Mycol. **3**:38. 1938.

This differs from the preceding section mainly in having dull red or pink tubes. The viscidity of the pileus is not always as strongly developed as in the other sections, but the hyphae of the cuticle are remarkably loosely arranged and imbedded in a gelatinous mass. While in other sections the color of the mycelium usually ranges from white to dirty drab or from white to pink, it tends to yellow in the *Piperati*. Two species are known, the type species *S. piperatus* (Bull. *ex* Fr.) Kuntze, Rev. Gen. Plant. 3^2:535. 1898 with its variety *amarellus* (Quél.) Sing. and *S. rubinellus* (Peck) Sing. None of these has ever been found in Florida.

SPECIES INCOMPLETELY KNOWN

Rostkovites californica Murr., *Boletinus flavoluteus* Snell, *B. glandulosus* Peck are some species apparently belonging in *Suillus* but not well enough known to this author. They have no bearing on Florida species, nor, like any other species that may enter into this category, do they have outstanding taxonomic significance.

SPECIES EXCLUDENDAE

Suillus castaneus (Bull. *ex* Fr.) Poir. *in* Lam. *ex* Karst.
Suillus cyanescens (Bull. *ex* Fr.) Poir. *in* Lam. *ex* Karst.

Suillus subalbellus (Murr.) Sacc. & Trott.

Suillus atroviolaceus Hoehn.

All these species belong in *Gyroporus*, not in *Suillus* S. F. Gray.

Suillus jamaicensis (Murr.) Sacc. & Trott. is not a *Suillus* in our sense, nor is it a *Gyroporus*, cf. p. 240.

Suillus hygrophanus Rostr. can be almost anything. No specimens seen.

Suillus cantharelloides (Jacobasch) Sacc. & Syd. is not a bolete.

Suillus Maxonii (Murr.) Sacc. & Syd.

This is a polypore, and, as the type (NY) shows, belongs in the genus *Polyporus sensu str.* The spores are hyaline, thin-walled, cylindric or cylindric-fusoid, 11–12 x 5 μ; hyphae of the tube-trama interwoven-subparallel, trama not bilateral but subregular, walls thin, clamp connections numerous. It is described from Costa Rica, and should be known as **Polyporus Maxonii** (Murr.) Sing. comb. nov.

Kuntze, Revisio Generum Plantarum 3^2:535–536. 1898, amused himself by transferring practically all known species of *Boletus* which he copied from Saccardo, to *Suillus* because of priority or what he used to call so. Personally, he has never seen any of them except perhaps *Boletus edulis* in his kitchen.

Subfam. **Xerocomoideae** Sing. subfam. nov.

Hyphis haud fibuligeris vel raro paucas fibulas gerentibus; sporis fusoideo-subcylindraceis, olivaceo-brunneis in cumulo (numquam roseolis nec flavis nec ferrugineis); pileo subtomentoso vel tomentoso jove sicco, saepe viscidulo jove pluvio; hymenophoro lamelloso interstitiis venosis vel tubuloso et tunc poris plerumque amplis, irregularibus, compositis praedito, sed nunquam typice boletinoideo, adnato vel decurrente; cystidiis hyalinis vel melleo-incrustatis vel melleo-tinctis; tramate hymenophorali subbilateralisubregulari (typi "phylloporoidei") strato laterali vix laxiore quam mediostratum leniterque tantum divergente; stipite solido, cylindraceo vel subcylindraceo, rarius ventricoso-subbulboso, glandulis veloque carente. Habitatio: Ad terram et ad lignum sub variis arboribus.

Characters of the subfamily: see key p. 227 and the above Latin diagnosis. Type genus: *Xerocomus* Quél.

Phylloporus Quél., Flor. Mycol., p. 409. 1888.

This genus has all the characters of the first section of the following genus of this subfamily except for the different configuration of the hymenophore. This is the only genus of the Boletaceae with gills instead of tubes. It can, however, be distinguished from all gill fungi by its characteristic bright and deep blue to green-blue reaction with ammonia on the surface of the pileus and the structure of the young gill trama. The hyphae are usually clampless but in some specimens some rare clamps can be observed if carefully and patiently searched for. The type species is *P. Pelletieri* (Lév. *apud* Cr.) Quél. which in its turn is the same as *P. rhodoxanthus* (Schw.) Bres. ssp. *europaeus* Sing. Another subspecies of this species occurs in Florida.

11. **Phylloporus rhodoxanthus** (Schw.) Bres., Fung. Trid. **2**:95. 1900.

Agaricus rhodoxanthus Schwein., Schr. Naturf. Ges. Leipzig 1822, **1**:83. 1822.
Paxillus flavidus Berk., Lond. Jour. Bot. **6**:315. 1847.
Paxillus pinguis Hook. fil. *apud* Berk., Hook. Journ. Bot. **3**:41. 1851.
Agaricus Pelletieri Lév. *apud* Crouan, Flor. d. Finistère, p. 81. 1867. (=ssp. *europaeus* Sing.)
Agaricus paradoxus Kalchbr., Icon. Fung., p. 27. 1873 (=ssp. *europaeus* Sing.)
Paxillus paradoxus Cooke, Grevillea **5**:6. 1876 (=ssp. *europaeus* Sing.).
Clitocybe Pelletieri Gill., Champ. Fr., p. 170. 1878 (=ssp. *europaeus* Sing.)
Gomphidius rhodoxanthus Sacc., Syll. **5**:1139. 1887.
Flammula rhodoxanthus (*sic*) Lloyd, Myc. Not. **1**(no. 3):17. 1899.
Paxillus sulcatus Pat., Bull. Soc. Myc. Fr. **5**:7. 1909 (=ssp. *americanus* Sing.?).
Paxillus rhodoxanthus Ricken, Blätterp. **1**:95. 1911 (formally ssp. *americanus*)
Phylloporus bogoriensis Hoehn., Fragm. Mycol. **16**(838):41. 1914 (=ssp. *bogoriensis* Sing.)
Paxillus Pelletieri Velen., Cesk. Houby **2**:356. 1920 (=ssp. *europaeus* Sing.)
Phylloporus sulcatus Gilbert, Bolets, p. 88. 1931 (=ssp. *americanus* Sing.?)
Phylloporus paradoxus Cleland, Toadst. & Mushr. **1**:178. 1934 (formally=ssp. *europaeus*)
Gomphidius foliiporus Murr., Mycologia **35**:432. 1943 (=ssp. *foliiporus* Sing.)
?*Agaricus Tammii* Fr., Öfvers. K. Vetensk.-Akad. Förh. **18**(1):24. 1861.
?*Gymnocybe Tammii* Karst., Hattsw., p. 412. 1879.
?*Paxillus Tammii* Pat., Tab. Anal. Fasc. **4**:161. 1885 (*descr. et fig. excl. quae=P. rhodoxanthus* ssp. *europaeus*)
?*Flammula Tammii* Sacc., Syll. **5**:810. 1887.

PLATE I, FIG. 11–12.

Ssp. **foliiporus** Murr. *l.c.*

Pileus when fresh between "maroon" and "claret brown," or between "russet" and "hazel," or "russet," or "ochraceous tawny," or "buckthorn brown," when old (sooner in sunny weather) fading to between "buckthorn brown" and "Isabella color" or to between "Isabella color" and "chamois," non-viscid, subtomentose or tomentose, in many specimens with soft wart-like projections, glabrescent with age, and often becoming rimulose or rimose (mostly concentrically), with the margin forming an obtuse angle (about 90°) in old specimens, convex, soon with flat or even slightly depressed center, margin eventually also flattening, 18–145 mm. broad. — *Hymenophore* "strontian yellow" or between this and "lemon yellow", turning blue in fresh material where wounded, eventually more sordid-brownish, decurrent, lamellae broad (7–14 mm. broad), their edges never forming pores and only the bases (near the line of attachment to the context of the pileus) up to one third of the breadth of the lamellae, rarely higher up, connected by transversely or obtusely forking veins, the sides of the lamellae often transversely veined, the edges entire and somewhat darkening in age; spore print brownish olivaceous, becoming "chipmunk" (M. & P.) in older herbarium preparations. — *Stipe* reddish brown above (colors much like those of the pileus), at least the furfuraceous squamulae or farinaceous pruinosity of the apex, and also the thin ribs continuing the lamellae, besides with a belt of reddish brown below the apex in most specimens, otherwise more olivaceous below, or yellow (concolorous with

the hymenophore) above, the reddish-brown colors eventually gradually disappearing, grayish greenish pallid below from a tomentose-flocculose covering, or, if glabrous, merely pallid there, not viscid, solid, equal or tapering downward, 16–55 x 2–40 mm.; mycelium either yellowish white or rich yellow; veil none. — *Context* yellowish white, pale yellow, or yellow, bluing when quite fresh and young; odor faint as in *Xerocomus subtomentosus*, *X. illudens* etc.; taste mild.

Spores 11–15 x 4.5–5.8 μ, melleous, smooth, oblong-ellipsoid to subfusoid, often the upper half only tapering to the apex; *basidia* 29–42 x 8–14.5 μ, mostly 4-spored, only occasional 3-spored ones mixed in, which measure 31–36 x 7.5–8.5 μ, and very rare 2-spored ones exceptionally found (*e.g.* 43 x 6.5 μ); *cystidia* 51–95 x 7–20 μ, fusoid, more rarely clavate, rarely cylindric, apiculate but obtuse at the tip, hyaline or with a melleous apex, rarely entirely melleous, and very slightly so in most cases, numerous, especially near the edges, the larger ones mostly found near the edges; *trama* consisting of a mediostratum of subparallel-subinterwoven hyphae that are more irregularly interwoven near the base of the lamella, and a lateral stratum of slightly though distinctly divergent (parallel with each other) hyphae which are not or not much more loosely arranged than the hyphae of the mediostratum and consequently also not or not much paler than these; *hyphae* in most carpophores without clamp connections, but occasional carpophores with a few clamped septa are observed.

Chemical reactions: **KOH** on surface of pileus, deep rich blue; on lamellae, brown; on context brownish. — **NH_3** and **NH_4OH** on not yet discolored surface of pileus, quickly bright but intensely pure blue to green-blue, eventually reaching "Hay's brown" as everywhere else in the carpophore. — **Aniline** negative. — **Formol** negative. — **Methylparamidophenol** negative.

Habitat: On the ground in hammocks as well as in open woods, also on trunks of trees (*Sabal*, *Quercus*, *Pinus*) in frondose woods, mostly near *Quercus* spec., and also in coniferous woods, mostly near *Pinus australis*, solitary or gregarious, fruiting from May to November.

Distribution: Florida.

Material studied: **Fla.,** Highlands Co., Highlands Hammock State Park, *R. Singer*, *F 223/I* and *F 223/I a* (FH), *F 632* (FH); Sebring, *R. Singer*, *F 439* (FH); Polk Co., Lake Alfred, *A. S. Rhoads* (*det.* Murrill) (FLAS); Alachua Co., Gainesville, *R. Singer*, *F 2183* (FH); *F 2629* (FH); *W. A. Murrill*, (**authentic**) *F 17990* (FLAS); Sugarfoot Hammock, *E. West*, *L. Arnold*, *W. A. Murrill*, *F 17747* (**type**) (FLAS, FH); *F 17774* (**cotype**) (FLAS); *F 15728* (FLAS); *F 18157* a young stage, **authentic** *F 18157* (FLAS); Magnesia Springs, *E. West*, *L. Arnold*, *W. A. Murrill*, (**authentic**) *F 17991* (FLAS); Columbia Co., High Springs, *W. A. Murrill*, (**authentic**) *F 15599* (FLAS); Dade Co., Brickell's Hammock, Miami, *R. Singer*, *F 940* (FH).

P. rhodoxanthus ssp. *foliiporus* (Murr.) Sing. is found in two forms, one with yellow mycelium, and another one with whitish mycelium. It is pos-

sible that these are hereditary forms which however would be of negligible taxonomic importance unless coupled with some other character. We have not been able, thus far, to ascertain any correlation of this kind.

When reading the diagnosis of *Gomphidius foliiporus* Murr., one may be impressed by the allegedly pallid lamellae and the dark spores. The specimens, however, including the type, do not show any appreciable differences, either macroscopical or microscopical, from the specimens determined by Murrill as *Phylloporus rhodoxanthus*. In fact, the latter as well as *G. foliiporus* are identical. The common *Phylloporus* in and around Gainesville, Fla., always had yellow lamellae when young and fresh, never pallid ones, and the spores were of the ordinary color in the Xerocomoideae in print as well as under the microscope. Fries indicates spores of a different color for his *Agaricus Tammii*, but this should not have influenced the descriptions of *P. rhodoxanthus* because Fries' indication is either an error, or *A. Tammii* is not a *Phylloporus* but rather a *Gymnocybe*.

This does not mean that *G. foliiporus* is a plain synonym of the northern *P. rhodoxanthus*. It is rather a geographic race of the latter. The difference between this and the other races of *P. rhodoxanthus* does not consist in the characters emphasized by Murrill but in the characters opposed to each other in the following key.

KEY TO THE SUBSPECIES OF PHYLLOPORUS RHODOXANTHUS

A. Context changing to blue (green), or "black" by autoxydation when wounded, at least lamellae bluing or "blackening" when quite young and fresh; tropical and subtropical races.
  B. Spores 11–15 x 4.5–5.8 μ; American race. ssp. *foliiporus*
  B. Spores 7.5–11 x (3.5)–4–5 μ; East Indian race. ssp. *bogoriensis*

A. Context unchanging or changing to reddish or brownish red when wounded; lamellae never bluing or blackening even when young and fresh. Temperate races.
  C. Anastomoses of the lamellae constant and broad (high), reaching half the breadth of the lamellae, or more, more rarely less; decurrent ribs at the apex of the stipe forming a proliferation of the lamellae, either absent, or rather indistinct, even if mycelium yellow. ssp. *europaeus*
  C. Anastomoses of the lamellae mostly vein-like, rarely higher and then only toward the margin of the pileus, or near the stipe, and even there not surpassing half the breadth of the lamellae, sometimes entirely lacking; from the point of attachment of each lamella at the stipe, a longitudinal vein or rib runs down the apex of the stipe in all forms with yellow mycelium; American race. ssp. *americanus*

Ssp. **bogoriensis** (Hoehn. *l.c.*) Sing. comb. nov.

The examination of the type material (FH) makes it evident that this species is another race of *P. rhodoxanthus*. Aside from the somewhat problematic difference between bluing and blackening, we find the spores slightly smaller in all three collections from Java than they are in our Florida material; the basidia are about 35 x 10.5 μ, 4-spored; cystidia either hyaline or brownish, cylindric, clavate, or fusoid, with 0.8 μ thick

walls, bluntly rounded at apex, numerous, especially near the edge, 44–105 x 11–20 μ; tramal structure as in ssp. *foliiporus*; no clamps seen.

Assuming as wide a variation of characters as is found in the Florida subspecies, it may be concluded that all three collections of Hoehnel's are the same thing. Even the material marked "Tjibodas" and "Zwergexemplare" is hardly different though it shows some similarities with material collected in Indo-China and China which rather belongs in ssp. *americanus*. Specimens without notes on color changes from the Singapore Botanic Garden were collected by Baker and remained undetermined in Patouillard's Herbarium (FH). I think they belong to ssp. *bogoriensis*.

Ssp. **americanus** Sing., Rev. de Mycol. **3**:171. 1938.

Lloyd has first mentioned the difference in the hymenophore of the American form, the type form of *P. rhodoxanthus*, and the European form. The specimens we have collected in this country and the specimens preserved in the herbaria, as far as they have been found in North America, can be divided in two basic forms, one with whitish mycelium, and wanting ribs on the apex of the stipe, and one, usually larger, with yellow mycelium, and very distinct longitudinal veins or ribs on the apex of the stipe. The form with whitish mycelium has been found in New Brunswick, Canada, and in northern New England, while the form with yellow mycelium is known from southern New England to the Carolinas and perhaps Georgia. The type of *P. rhodoxanthus* ssp. *americanus* Sing. is, of course, the specimen on which Schweinitz based his *Agaricus rhodoxanthus*, and this is obviously the form with yellow mycelium. It so appears that the form with white mycelium does not belong in the same subspecies with the typical ssp. *americanus*. However, more data are needed in order to make sure that this actually is another geographical race, and besides, it will have to be proved that it is not identical with any European form.

The spores are rather variable in both American forms, in the white-mycelioid form varying from 10–11 x 3.3–4 μ in New Hampshire material to 11.5–13.5 x 4–4.8 μ in New Brunswick material; in the yellow-mycelioid form they usually are 10.5–12.5–(14.3) x 4–5.5 μ; basidia 20–30 x 6–8.3 μ, with four 5 μ long sterigmata; cystidia hyaline or in old herbarium specimens with a slight yellowish tinge, cylindric or cylindric-fusoid, also sometimes clavate with 0.5–0.8 μ thick wall, rather numerous to very numerous, 50–111 x 6–19 μ; trama as in the other subspecies; no clamps found.

Material from eastern Asia seems to belong here. The description given by Imai for Hokkaido material fits well. We have also examined Chinese collections with the spores 9.2–15 x 3.7–5.5 μ; basidia 29–32 x 7–9 μ, 4-spored; cystidia hyaline to very pale yellowish with 0.7 μ thick wall, clavate or fusoid, also sometimes cylindric, 40–110 x 7–19 μ; trama as in the other subspecies; clamps none; color of the mycelium yellow; ribs at apex of stipe distinct. Patouillard's type (FH) of his *Paxillus sulcatus* from Indo-China has 11–12.8 x 4.5–5–(6) μ large spores (a few foreign spores from *Boletellus*, probably *B. emodensis*, have fallen onto the hymenophore of the

type specimen); basidia and cystidia as in the yellow-mycelioid form of ssp. *americanus*.

Lebedeva claims that she had *P. rhodoxanthus* from the Far-Eastern Province of the U.S.S.R. Thus this race probably occurs all through Eastern Asia from there through Japan and Eastern China to French-Indo-China.

Ssp. **europaeus** Sing., Rev. de Mycol. **3**:171. 1938.

Good European material from St. Johann in Tyrol, *v. Hoehnel*, 1908 (FH) has recently been consulted by this author and the mycelium has been found to be yellow while the apical ribs were absent or very indistinct; the spores were 11–14 x (3.3)–4.2–5 μ; basidia 35–44 x 8.5 μ, 4-spored; cystidia yellowish-brownish to hyaline, 45–70 x (5.5)–10 μ, fusoid; trama not studied, clamps none.

SPECIES INCOMPLETELY KNOWN

Phylloporus infundibuliformis (Cleland) Sing. comb. nov.
Paxillus infundibuliformis Cleland, Toadst. & Mushr. **1**:175. 1934.

This is evidently a *Phylloporus* but not conspecific with *P. rhodoxanthus*, as far as can be concluded from the description. What is described as *P. paradoxus* by Cleland is a subspecies of *P. rhodoxanthus*, probably an undescribed one, or else ssp. *americanus* or ssp. *bogoriensis*.

SPECIES EXCLUDENDAE

Phylloporus malaccensis Pat. & Baker is *Porphyrellus malaccensis* (Pat. & Bak.) Sing.
Phylloporus intermedius Pat. is *Gyrodon intermedius* (Pat.) Sing.
Phylloporus Rompelii Pat. & Rick.

This species is *Gyrodon Rompelii* (Pat. & Rick) Sing., and perhaps a variety of *G. merulioides* (Schw.) Sing.

Phylloporus lariceti Sing.

This species is here treated as the type of the new genus *Psiloboletinus*.

Phylloporus squarrosoides (Snell & Dick) Sing.

This species may very well be treated as a *Phylloporus*, but in the present arrangement it is transferred to *Xerocomus*.

Xerocomus Quél., Flor. Mycol., p. 417. 1888.
Xerocomopsis Reichert, Palest. Journ. Bot., Reh. Ser., **3**:229. 1940.

Pileus more or less tomentose or subtomentose, frequently with at least fragmentary trichodermium-pallisade; hymenophore not lamellate but occasionally subboletinoid, most frequently with rather wide and angular pores, adnate, often with a decurrent tooth, or arcuate-decurrent, more rarely becoming depressed around the stipe and then usually with the radial walls of the tubes forming a sublamellate ring around the apex of

the stipe, not free, but sometimes separating in age; stipe usually cylindric or subequal and rather thin, more rarely some other shape, and very rarely ventricose-bulbous as in *Boletus*, sometimes with an ocher brown or yellow coarse network at the apex, never finely reticulate as in *Boletus*; veil none; yellow pulverulence none; spores variable in size but constant in shape, *i.e.* always subcylindric to subfusoid, or oblong-ellipsoid to ellipsoid-subclavate, always olivaceous-brown in print (never yellow, ferruginous, pinkish-vinaceous etc.); trama of the hymenophore subbilateral of the *Phylloporus*-type, *i.e.* the lateral stratum scarcely (if at all) lighter colored, and scarcely (if at all) looser than the mediostratum, its hyphae though distinctly diverging in youth, not strongly bent outward, and not distinctly imbedded in a mucilaginous mass, parallel with each other; hyphae without clamp connections; cystidia medium-sized to rather large, not strikingly incrusted or not incrusted at all, not in fascicles; setae none; mycelium white or yellow, not constantly forming mycorrhiza with conifers (except a few species which do not occur in Florida). — The type species is *Xerocomus subtomentosus* (L. *ex* Fr.) Quél.[13]

The genus *Xerocomus* is the one genus among the Boletineae that is most difficult to delimit, and yet it appears to be indispensable from a practical as well as theoretical point of view. It undoubtedly represents itself as a link between *Phylloporus* on one side and *Boletus sensu str.* on the other. As for its limits with *Phylloporus*, I have been tempted to redefine *Phylloporus* by introducing into that genus species with definite pores such as *Xerocomus illudens* and the related species showing the characteristic vivid blue ammonia-reaction on the surface of the pileus known also in *Phylloporus*. In fact these species are so closely related to *Phylloporus* that they almost form a continuous line, and the dividing line between *Phylloporus* and *Xerocomus* could as well have been drawn along chemical as along macro-morphological characters. Unfortunately these convenient and reasonably sharp characters are not entirely parallel, since the blue ammonia-reaction is found on some porous species. I finally chose the macro-morphological criterion for the distinction of the two genera for two practical reasons. First, this character has in its favor tradition as well as the greater convenience of immediate recognition in old, dry, or dried material. Second, a modification of the vivid blue reaction which is found in other species of *Xerocomus* either as a flash of black-blue or a livid-caesious ring around the stained spot, or a violet shade of blue, may cause confusion notwithstanding their obvious difference from the coloration observed in *Phylloporus*. This more conservative solution, leaving *X. illudens* and allied forms

[13] It would mean to reduce *Xerocomus* to the status of a synonym of *Boletus*, if the first species mentioned by Quélet, *Xerocomus impolitus* were to be the type of the genus, as has been proposed by others. This latter proposal, however, was made as a consequence of a misinterpretation of the rules which do not prescribe the choice of the first-described species. *Xerocomus*, as conceived by its author, is the group centering around *X. subtomentosus*, and therefore this author in 1936 proposed this latter species as lecto-type.

in *Xerocomus*, has also the advantage of keeping within a single genus such species as *X. illudens*, *X. spadiceus sensu* Quél. = *X. coniferarum* and *X. subtomentosus* which were in the past even considered to be varieties of one and the same species. I may add, however, that there is not enough evidence to prove that *X. illudens* and *X. coniferarum* actually are more closely related to the rest of the *Xerocomi* than with *Phylloporus*.

On the other extreme of the genus *Xerocomus* are forms which apparently gradually approach the genus *Boletus sensu str.* In these, the pores are somewhat smaller than in the others, and the structure of the lateral stratum of the hymenophoral trama becomes more truly bilateral (*Boletus*-type). In fact, even macroscopically, no sharp line between these two genera can be drawn. If, however, the exact structure of the trama and the affinities of every single intermediate species are checked and weighed, a line between these genera will result that is somewhat hard to define but evidently leaves related forms together and makes both genera as natural as possible.

Two important papers on the anatomy of the hymenophoral trama in the boletes have appeared recently. The first authors to mention the difference between what we call the *Phylloporus*-type and the *Boletus*-type, were Lohwag and Peringer (Ann. Mycol. **35**:295–338. 1937). Their results were checked by this author on the limited amount of material in 1938 and found to be correct. I may add that in my key to the genera of the Agaricales (Schweizer. Zeitschr. Pilzk. **17**:7. 1939) I have for the first time used the two types of bilaterality for taxonomic purposes. In a later paper, Elrod and Blanchard (Mycologia **31**:704. 1939) also published on the structure of the trama of the Boletaceae but did not arrive at the same results as their predecessors. In fact, they concluded that though there was plenty of difference in different species, this difference did not coincide with any classification based on other characters and can therefore not be used for taxonomic purposes. I have regretted that these authors did not publish precisely what structure they found in what species and at what stage. If they had, it would probably become more apparent that the differences they found cannot, in many cases, be used for taxonomic purposes because they do not exist between species but between stages. I have now checked on young and good material of most of the specimens available for this purpose (see descriptions and notes on extralimital material), and rechecked on my own findings in long and tedious investigations. If care is taken to use for these investigations nothing but comparatively recent collections and carpophores just beginning to sporulate, it will be found that there is a bilateral trama in all Boletaceae with a single modification, that is the existence of the *Phylloporus*- and *Boletus*-type of bilaterality. As soon as the tubes begin to elongate, the divergence of the hyphae of the lateral stratum diminishes slowly until it finally reaches zero *i.e.* the hyphae show a generally axillar direction, parallel with each other and with the mediostratum. On the other hand, there is no bolete among the scores of specimens I have sectioned that does not show distinctly (though to a different

degree) divergent hyphae in the lateral stratum at a certain age. Even the difference between the *Phylloporus*- and *Boletus*-type is rather a quantitative than a qualitative one. It is only natural that, under these circumstances, intermediate structures occasionally may be observed. An example is section *Pseudoboleti* with thus far one species, *X. badius*. Since the disposal of the species with intermediate structure has been taken care of in an arbitrary way, with the idea of keeping related forms together, the keys to the species of *Boletus* (now in preparation) take into account both species here considered as belonging to *Xerocomus*, and species considered as *Boletus* (*sensu str.*).

KEY TO THE SECTIONS

A. Spores short (Q=2, or less), *or* reaction of the surface of the pileus with ammonia an intense, vivid pure blue or green-blue (about "porcelain blue" or "dusky green blue"), not blackish blue, nor violet, livid, or caesious. Sect. 1. *Pseudophyllopori*

A. Spores elongate *and* reaction with ammonia not as described above.

B. Pileus not or scarcely viscid in wet weather; species growing entirely as saprophytes, or with northern forest trees, or parasitic on fungi.

C. Not parasitic on fungi; spore production of the hymenophore abundant; context potentially bluing, or at least fresh tubes sometimes bluing. Sect. 2. *Subtomentosi*

C. Parasitic on fungi (Sclerodermatineae); spore production not as active as in other boletes; context not or scarcely bluing, not even in the tubes. Sect. 3. *Parasitici*

B. Pileus distinctly viscid in wet weather; either forming mycorrhiza with northern conifers exclusively, or connected with southern hardwoods, sometimes in open places.

D. Carpophores small; spores smaller than 10 μ; context and pores unchanging; species never connected with conifer mycorrhiza. Sect. 4. *Brasilienses*

D. Carpophores medium to rather large with medium (longer than 10 μ) to rather large spores; context bluing; northern species, always connected with conifer mycorrhiza. Sect. 5. *Pseudoboleti*

Sect. **Pseudophyllopori** Sing. sect. nov.

Sporis breviusculis (quotiente e longitudine et latitudine vix superante 2) aut reactione NH_3 et NH_4OH in superficie pilei provocata intense azurea vel viridulo-azurea.

Characters of the section: Pileus not viscid; surface of pileus in the species studied turning immediately to an intense, vivid pure blue or green-blue (about "porcelain blue" or "dusky green blue"), at least when young and fresh, neither water-soaked nor too dry; pores wide; spores either short (Q=2, or less), or of normal elongated shape; context bluing or not bluing; habitat on the ground or on wood in frondose and coniferous woods, hammocks, and in gardens near trees, never parasitic on fungi.[14] — The type species is *X. illudens* (Peck) Sing. (*Boletus illudens* Peck).

[14] It is not known whether these species form mycorrhiza. If they do, they evidently prefer frondose trees, especially oaks, hornbeam, and perhaps sweet gum and others. However, one species grows with conifers (*X. coniferarum*).

KEY TO THE SPECIES

A. Spores with Q averaging around 2 or somewhat smaller.

B. Pores large, subboletinoid, angular; spores 9–12 x 4.5–6 μ. *X. squarrosoides*

B. Pores medium-sized, circular to oblong; spores 7.7–8.5 x 5 μ. *X. Housei*

A. Spores with Q decidedly above 2.

C. Stipe without a network in all specimens of a given group, *i.e.* constantly smooth; spores 4–5 μ broad or broader; growing with oaks (in Florida).

D. Base of stipe distinctly bright yellow; mycelium yellow; carpophores small and thin. 12. *X. hypoxanthus*

D. Base of stipe not distinctly yellow; mycelium yellowish white to white; carpophore large and thick (in Florida).

E. Floridan species; carpophores large, thick, growing in scrub and in low oak woods; hymenophore a rich yellow 13. *X. pseudoboletinus*

E. African species; carpophores rather small and rather thin, growing at the base of termite nests; hymenophore pinkish cinnamon. *X. Linderi*

C. Stipe with a network, at least at the apex in most specimens of a group (sometimes the network is incomplete, and replaced by a coarse brown punctation on yellowish ground, but the majority of carpophores shows them connected enough to form a well-distinguishable network); spores either about 4–5 μ broad, or narrower.

F. Pileus usually tapering down into the thin, frequently curved stipe, and thus the hymenophore distinctly arcuate-decurrent; tubes very gradually transient into the coarse network (ridges or punctation) of the stipe; mycelium white or yellowish white; spores 4–5 μ broad; habitat around trunks in dense hammocks, more rarely farther away from the trunks on humus. 14. *X. hemixanthus*

F. Pileus not shaped as described above, and consequently the hymenophore either flatly adnate (though sometimes plainly decurrent on one side because of irregularity of growth), and only slightly decurrent with a tooth, the walls proliferating into the network of the apex of the stipe but not very gradually so; mycelium yellowish white or yellow; spores 3.5–4.2 μ broad in eastern species, often broader in others; growing in small groups not arranged around the trunks of trees, usually in rather open stands of northern woods, or in partly cultivated hammock land, in gardens etc.

G. In beech woods (*Fagus*) and in coniferous woods, in Europe, perhaps in North America; spores (3.5)–4–5–(6) μ broad, most frequent sizes 11.5–13 x 4.8 μ; mycelium yellow and then carpophores large and the stipe not tapering downwards, *or* mycelium white and then carpophores medium-sized to rather small with the apex of the stipe deeply reticulate.

H. Stipe brown, very strongly reticulated, pallid near the base, equal or tapering downward; carpophores medium-sized, or perhaps rather small; in beech woods (according to Rostkovius). *X. lanatus*

H. Stipe yellow with more or less deeply decurrent brown network; the base and the mycelium yellow, stipe subequal or tapering upward; large plant in coniferous woods. *X. coniferarum*

G. In mixed oak woods and on lawns and in gardens under frondose trees other than beech, mostly oak in the eastern part of North America; spores 3.5–4.5 μ broad, most frequently 10–11.7 x 3.5–4.1 μ; mycelium yellow and then carpophores medium-sized and the stipe distinctly tapering downward in most cases, *or* mycelium white or yellowish white, and then carpophores large with the stipe yellow and brown-reticulate. 15. *X. illudens*

I. Mycelium white to yellowish white; carpophores large (pileus 63–123 mm. broad; stipe 40–60 x 25–35 mm.); the brown network of the stipe usually reaching deep toward the base. Northern plant. ssp. *typicus*

I. Mycelium yellow; medium-sized carpophores (pileus 43–87 mm. broad; stipe 35–70 x 8–18 mm.); the brown network of the stipe usually confined to the upper portion of the stipe. Known only from Florida. ssp. *xanthomycelinus*

12. **Xerocomus hypoxanthus** Sing. spec. nov.

Pileo dilute brunneolo, ochraceo-brunneo-punctatulo (velutino-punctatulo vel fibrilloso-granulosulo) vel tomentoso, sicco, convexo, 26–66 mm. lato, ammonici ope vivide azureo; tubulis flavis, deinde subolivaceis, saepe tactu subvirescentibus, adnatis vel subdepressis; sporis 11–14 x 4.2–5.2 μ, brunneo-olivascentibus in cumulo recente; stipite flavo, deorsum pallido vel pallide flavo, sed brunneolo-granuloso-subsquamuloso, squamulis minutis subsparsis obtecto, aequali, mycelio flavo, 30–50 x 4–10 mm.; carne alba vel albida, flavidula vel flava, laesa subtiliter caerulescente in pileo, inodora, miti. Habitatio: In dumetis subtropicis ("low hammock") et silvis arenosis ("scrub") prope quercus et arbores alias frondosas aestate in Florida Americae Borealis.

Pileus pale brownish but appearing much more vivid brown because of a dense fibrillose-granular velvet or a tomentum that is "mahogany red," "Brussels brown," "russet," "Mars brown," or "ochraceous tawny," and by side view (seen at an acute angle) usually rather "buckthorn brown," non-viscid, only subviscid when wetted thoroughly, not reddening in cracks, 26–28 mm. broad but occasionally reaching 66 mm. in diameter. — *Hymenophore* "strontian yellow" with a tinge of "oil yellow" or "pyrite yellow," adnate-subdecurrent or planely adnate, or slightly depressed around the stipe, or lamellately stretched near the stipe, and finally separating from it, pores concolorous and greening on pressure or unchanging, wide; spore print not obtained in thick enough layer but of about the same color as in the following species. — *Stipe* pallid to pale yellow or pale tawny and mostly more vivid yellow at the apex ("light cadmium" to "lemon chrome"), and usually likewise yellow at the very base where the finely fibrillose bright yellow mycelium is attached, the yellow of the surface of the middle portion usually obscured by the "Argus brown" granular punctation or furfuraceous pustulation which becomes denser downwards but is usually sparse and the particles minute farther above, though occasionally it forms an annular belt of denser granulae (not a veil), non-viscid, solid, thin, subequal or equal, 20–32 x 2–4.5 mm. but sometimes reaching 50 x 10 mm. — *Context* white or with a very faint yellowish tinge in the pileus, reaching "Martius yellow" to "strontian yellow," pallid to light yellow in the stipe

but often lemon yellow in the apex of the stipe and often marbled, the context of the pileus never becoming reddish in wounds or cracks, unchanging when bruised, or sometimes slightly bluing; taste mild; odor none or very slight, like that of *Boletus edulis*; taste mild.

Spores (8.2)–11–14 x 4.2–5.2 μ, smooth, melleous, fusoid with suprahilar depression; *basidia* 26–41.5 x 8.5–11 μ, most frequently 26–36 x 9.5–10 μ, 4-spored, very rarely some few basidia 2-spored; *pseudoparaphyses* clavate with subcapitate apex, or basidiomorphous, *e.g.* 33 x (5)–8–11.5 μ, not always present; *cystidia* 34–70 x 6.8–12.2 μ, fusoid with the thickest portion in the middle or in the upper third, with the apex obtuse and often ampullaceous protracted, hyaline, rather numerous; *trama* of the tube-walls of the same general type as in *X. illudens*; all *hyphae* without clamp connections.

Chemical reactions: **KOH** on pileus, dark and intense blue, in older and drier material "amber brown" to "Argus brown"; on the tubes, light brown to brown; on the squamulae of the stipe, deeper brown but ground color unchanged. — **NH_4OH** on the surface of the pileus, deep and rich blue to green-blue when young and fresh, slightly bluish to negative when old or dry; on context, blue to bluish when fresh.

Habitat: On trunks of palmetto between old petioles, on very decayed frondose wood, on the base of frondose trees, or on humus and débris in low and mesophytic hammocks, and on dry sand in scrub areas, from July to September.

Distribution: From Georgia (and perhaps Virginia) south to Florida (except in the tropical part of the state).

Material studied: **Fla.** Highlands Co., Highlands Hammock State Park, *R. Singer, F 626* (**type,** FH); *F 37* (**co-type,** FH); *F 357* (**co-type,** FH); *F 579/I* (**co-type,** a large form of the scrub, FH); Alachua Co., Sugarfoot Hammock, *R. Singer, F 2473 b* (FH); *F 2590/I* (FH). — **Ga.** Tallulah Falls, *A. B. Seymour* (FH).

The combination of characters in this usually small bolete is constant in all collections, and it does not seem to have been described before.

13. **Xerocomus pseudoboletinus** (Murr.) Sing. comb. nov.
Ceriomyces pseudoboletinus Murr., Lloydia 7:324. 1944.

Pileus "mahogany brown," "Verona brown," "russet," later "sayal brown," "Mikado brown," "ochraceous tawny," or with some "Sanford's brown," or (because of the unequal development or partial lack of the cuticle) as pale as "honey yellow" in the center and "chamois" to "cream buff" on the margin, occasionally with some "pinkish buff" to "pinkish cinnamon" mixed in, sometimes more "cameo brown" at places, tomentose to subvelutinous, more tomentose toward the margin, partially and unequally glabrescent and often areolate-squamose, the squamulae appressed, becoming more distinctly rimulose when old, the yellow of the flesh showing through the crevasses or squamulae, dry, rugulose to smooth, margin incurved and slightly projecting when young, the projecting portion pallid

underneath, pulvinate, then convex with an occasional depression in the center, 40–170 mm. broad. — *Hymenophore* "lemon chrome" or between "lemon chrome" and "lemon yellow," or "sulphine yellow," becoming "sulphine yellow" or "lemon yellow" when older, then "citrine" with more "lemon yellow" pores, adnate or shallowly depressed; tubes 10–17 mm. long, the radial walls of the tubes often short-decurrent (1–6 mm.) and occasionally with anastomosing lines; pores on unequal level, radially elongate, at least near the stipe, 0.5–2.5 mm. wide, 3–5 pores to 5 mm. radially, and 5–6 pores to 5 mm. transversely; spore print brownish olive. — *Stipe* "naphthalene yellow," "primulin yellow," "strontian yellow," or "ivory yellow" with "colonial buff" punctations, often at places almost white, often concolorous with the pileus near the base, or near the base or in the middle "onion skin pink," "pecan brown," or "walnut brown," dry, not reticulate, without furfuraceous or reticulate brown ornamentations, even at the apex, but with occasional short longitudinal coarse ribs which are subconcolorous with the pileus and rarely show a slight anastomosis, otherwise quite smooth, but never really glabrous because of a minute, mostly yellowish or pale tan punctation all over its surface, though often seemingly subglabrous because the punctation does not show except when observed with a lens, subequal or tapering downward and frequently with a strongly enlarged apex, solid, 35–50 x 8–18 mm., the apex sometimes up to 40 mm. wide. — *Context* "pale lemon yellow," "lemon yellow," or "barium yellow" near the tubes and yellowish white to "naphthalene yellow" or almost white with yellow stripes in the stipe, otherwise yellowish white to nearly white, often somewhat pinkish under the surface, either entirely unchanging in any part, or more rarely slowly and weakly greening in the deeper yellow portions of the context; odor of soap, or none; taste mild, submild, or scarcely bitterish.

Spores 10.2–13.7 x 4–5.5 μ, subfusoid or ellipsoid-oblong with suprahilar depression, more rarely without it, smooth, melleous; *basidia* 22.5–43 x 8.8–11.7 μ (larger in the dry scrub areas than in moist hammocks), hyaline to pale melleous, 4-spored; *cystidia* on pores and inside the tubes narrowly fusoid or broadly fusoid with long cylindric neck which rarely is subacute, and usually obtuse, hyaline to more rarely pale melleous, 37–56 x 4.5–8 μ; *cheilocystidia* sometimes differentiated, versiform; *trama* of the hymenophore decidedly of the *Phylloporus*-type; *hyphae* without clamp connections, hyaline.

Chemical reactions: **KOH** on surface of pileus, "amber brown," then "Argus brown" or still deeper brown, later becoming paler; on context of pileus, brownish; on context of stipe, negative or almost so; on tubes, brownish; on surface of stipe, negative. — **NH_4OH** (and also NH_3 vapors) on surface of pileus (if fresh enough), becoming "porcelain blue" to "dusky green-blue," less vivid on older caps, or in the old ones becoming "dull Indian purple" or duller, or deep brown on old, dry pilei, then becoming paler, the vapors usually reacting similarly[15]; the portions treated with

[15] In strongly cracked or squamose pilei, the reaction is likely to be indistinct.

$FeSO_4$ previously, and subsequently exposed to the action of ammonia show the same blue reaction as fresh young material, even if the material be rather old and dry (catalysis?); on context of stipe, negative except in some cases where the deep yellow portions of the flesh change to bluish green with ammonia. — **$FeSO_4$** on surface of pileus, see under NH_4OH; on context of pileus, slowly dirty greenish. — **H_2SO_4** on surface of pileus, reddish fulvous; on tubes, rusty-ochraceous; on context of pileus, negative then sometimes blue. — **HNO_3** on surface of pileus, reddish fulvous; on the entire context, slightly reddish brown, generally causing a richer and brighter color. — **Formol** on context of pileus, negative and later somewhat blue.

Habitat: Under scrub oaks (*Quercus Chapmanii* and other species) turkey oak (*Q. laevis*), water oak (*Q. nigra*), laurel oak (*Q. laurifolia*), live oak (*Q. virginiana*), with *Q. minima*, in the scrub, low open places, on lawns, and even in flatwoods, on dry sandy as well as on wet acid soil. Fruiting from July to October.

Distribution: Florida (excepting the tropical part).

Material studied: **Fla.** Highlands Co., Highlands Hammock State Park, in the scrub areas, *R. Singer, F 579* (FH); Alachua Co., near Dayville, southwest of Gainesville, near the pond, *R. Singer, F 2540*, (FH); *F 3029* (FH); between Gainesville and Newnan's Lake in flatwoods, *R. Singer, F 2841* (FH); *W. A. Murrill, F 19589*, **co-type,** (FLAS, FH); Gainesville, *R. Singer, F 2764* (FH); also less well-preserved material without notes, determined as *B. illudens* by W. A. Murrill (FLAS).

This species has obviously been considered as *B. illudens* by Murrill and later has been described as a new species by him. It was already given as a new species in this manuscript when a sample of *C. pseudoboletinus* reached me.

14. **Xerocomus hemixanthus** Sing. spec. nov.

Pileo brunneo vel brunneo-umbrino, castaneo vel ferrugineo in junioribus, fulvo-rubido vel ferruginascente in vetustis, tomentoso, pulvinato, dein applanato, 27–75 mm. lato; ammoniaci ope caerulescente; tubulis flavis vel flavo-melleis, in vetustus discoloratis, obtuse adnatis vel decurrentibus, plus minusve arcuatis, 5–11 mm. longis, poris concoloribus, amplis at moderate tantum radialiter elongatis, 1.5–2 mm. in diametro in maturis; sporis 10.3–15.3 x 4–5 μ; tramate typi *Phyllopororum*; stipite cremeo, ad apicem vel omnino castaneo-reticulato, aequali vel subaequali, saepe curvato, 30–60 x 5–12 mm.; mycelio albo vel lutescente-albido; carne aequaliter flava vel pallide flava, fracta frequenter caerulescente. Habitatio: In silvis densis frondosis (hammocks) circa et ad bases truncorum arborum, praecipue *Ostryae* aut rarius ad humum, Julio mense in Florida Septentrionali Americae Borealis.

Pileus between "snuff brown" and "Saccardo's umber," or "Dresden brown" when young, between "russet" and "auburn" when old, or similar in color through all stages and then between "chestnut" and "auburn," tomentose, becoming faintly granulose or rimulose-tessellate, non-viscid, pulvinate, then flat, 27–75 mm. broad. — *Hymenophore* "amber yellow," "honey yellow," "Isabella color," sometimes becoming as deeply colored as "Saccardo's umber," at last discolored golden brownish with age, broadly

adnate (with or without a decurrent tooth) or decurrent, more or less arcuate, tubes 5–11 mm. long, pores 1.5–2 mm. wide when mature, *i.e.* wide but only moderately radially elongate. — *Stipe* "cartridge buff" to "cream buff," apex or entire surface adorned with anastomosing ribs or a perfect network, the ribs coarse and "chestnut brown," rarely broken up into minute squamulae of the same color, solid, terete or compressed, equal or subequal, straight or more often curved, 30–60 x 5–12 mm.; mycelium white or yellowish white. — *Context* yellow or pale yellow in both pileus and stipe, occasionally slightly bluing, yellow in dried specimens; taste slightly acidulous or mild; odor none, in old specimens often recalling Roquefort cheese.

Spores 10.3–15.3 x 4–5 μ, fusoid, melleous, smooth; *basidia* 25–31 x 7.5–11 μ, 4-spored; *cystidia* 27–38 x 6–17 μ, rarely longer, always hyaline in well-preserved material, versiform, on pores fasciculate; hymenophoral *trama* of the *Phylloporus*-type; the lateral stratum little though undoubtedly divergent and no differentiation in color or density between it and the mediostratum visible; *terminal members of the cuticular hyphae* upright and often rather short to even subglobose (13–34 μ in diameter), broadly rounded above, not forming an actual epithelium, the rich ferruginous-chestnut-brown pigment squeezed out and dissolved in ammoniacal preparations; *hyphae* without clamp connections.

Chemical reactions: **KOH** on surface of pileus, deep castaneous; on tubes, brown; on context, ochraceous tan. — **NH_3** on surface of pileus and hymenophore, blue. — **NH_4OH** on surface of pileus, tan; on tubes, blue; on context, bluish. — **HNO_3** on surface of pileus, orange then reddish. — **H_2SO_4** on surface of pileus, orange then cinnamon; on tubes, orange-ferruginous.

Habitat: On the bases of the trunks of *Ostrya*, more rarely of *Liquidambar*, *Acer*, or *Carpinus*, usually on the trunks of living trees, rarely on dead trunks, sometimes on humous ground of mesophytic hammocks near *Ostrya* or *Liquidambar*; fruiting in July, gregarious.

Distribution: North Florida.

Material studied: **Fla.** Alachua Co., in and around Gainesville in mesophytic hammocks, *R. Singer*, *F 2473*, *F 2473 a*, *F 2473 b*, etc. (FH).

This species is unmistakable when found typically developed. In its external appearance, it is much like *X. hypoxanthus* but differs in the color of the mycelium and the chestnut brown raised lines on the apex of the stipe; the spores are slightly narrower on an average but there are collections where the spores are equally broad in both species. In *X. squarrosoides* which, at times, is also similar in stature, the spores are distinctly broader.

15. **Xerocomus illudens** (Peck) Sing. comb. nov.

Boletus illudens Peck, Ann. Rep. N.Y. State Mus. **50**:108. 1897.
Ceriomyces illudens Murr., N. Am. Fl. **9**:145. 1910.
Ceriomyces alabamensis Murr., N. Am. Fl. **9**:146. 1910 (a subspecies ?).
Boletus alabamensis Sacc. & Trott., Syll. **21**:242. 1912.
Ceriomyces flavimarginatus Murr., Mycologia **31**:110. 1939. (a subspecies), *p.p.*

Ssp. **typicus.**

Pileus "tawny" to "cinnamon rufous" when fresh, middle portion with "ochraceous tawny" and "cinnamon rufous" or "russet" stains on generally "buckthorn brown" ground, margin becoming slightly more grayish fuscous than "ecru-olive," center subtomentose, margin tomentose, non-viscid, convex, center sometimes depressed, margin thick and fleshy, 63–123 mm. broad. — *Hymenophore* mixed "strontian yellow" and "citron yellow," becoming "pyrite yellow" at last, adnate-subdecurrent, tubes 9–15 mm. long; pores concolorous, sometimes slightly bluing on pressure, 0.8–3.0 mm. wide. — *Stipe* between "primrose yellow" and "marguerite yellow," or between "ivory yellow" and "colonial buff," with either concolorous or tawny brown (color of the pileus) very coarse, wide network of strongly raised, strongly anastomosing lines, most distinct at the apex but reaching down to the very base, with a concolorous or "light pinkish cinnamon" faint fibrillosity at places, or almost all over its surface, solid, decidedly tapering downward, 40–60 x 25–35 mm. at apex; mycelium yellowish white. — *Context* yellowish white with pale brownish pink portions to nearly "massicot yellow," somewhat brownish inside the stipe; odor none, or slightly like *Boletus edulis* but weaker and less aromatic; taste mild.

Spores (8.2)–9.5–12.7–(13.6) x 3.5–4.5 μ, most frequently 10–11.7 x about 4.0 μ, melleous, smooth, ellipsoid-subfusoid to strongly fusoid; *basidia* 28–35 x 7.5–9.2 μ, (2)–4-spored; *cystidia* 42–56 x 6–11 μ, hyaline, non-incrusted, distinctly fusoid, thin- to moderately thick-walled; *trama* of the hymenophore not observed in proper condition, but of the general structure of the related forms; *hyphae* without clamp-connections.

Chemical reactions: **KOH** on surface of pileus, deep chestnut becoming "ochraceous orange" (but reaction weak and slow). — **NH_3** on surface of pileus, deep green-blue. — **$FeSO_4$** on tubes, more greenish and more gray; on context, almost negative.

Habitat: In mixed woods on the ground, from August to September.

Distribution: From New England and upper New York State south to the Carolinas and probably Alabama.

The above description is the result of the study of several good fresh specimens from Massachusetts, dried material from North Carolina (*Alma Holland Beers 12523*) and the type collection at Albany (NYS). Compare also Coker and Beers' description (*l.c.* p. 55). We included this description in order to make the comparison with the Florida subspecies possible.

Ssp. **xanthomycelinus** Sing. ssp. nov.

A subspecie typica mycelio luteo nec non statura paulum minore differt. Sub Quercubus in Florida Americae Borealis.

Pileus reddish brown to fulvous castaneous ("Mikado brown," "auburn," "chestnut"), tomentose, or subrimulose-tomentose when mature, non-viscid, pulvinate to nearly applanate, 43–87 mm. broad. — *Hymenophore* about "strontian yellow" or somewhat paler, becoming more olive yellow with age, adnate or adnate-subdecurrent and continued in the reticulation of the

apex of the stipe; tubes medium long; pores concolorous, unchanging, wide to very wide. — *Stipe* varying from pallid to yellow but if pallid it is covered with numerous dense minute flocculae which make the whole surface appear yellow except for the brownish (testaceous-cinnamon to reddish brown) ridges or ribs that form, on the upper third or two thirds of the stipe, a coarse network from which longitudinal lines frequently run downwards for some distance, solid, tapering downward from the very apex or from about the middle of the stipe, or only with a tapering base and otherwise subequal, 35–70 x 8–12–(18) mm.; mycelium light yellow to rich yellow. — *Context* white with yellow portions above the tubes, or light yellow throughout the pileus, white or sordid pale yellow in the stipe, not changing anywhere, slightly paler than the surface immediately under the cuticle of the pileus; taste mild; odor almost none.

Spores 9.5–14.2 x 3.5–4.5 μ, most frequently 10–11.5 x 3.5–4 μ, melleous, subfusoid-subellipsoid, smooth; *basidia* 24–30 x 7–9 μ, 4-spored, in few carpophores some 2-spored ones intermixed; *cystidia* 28–63 x 5.5–11.5 μ, fusoid or subfusoid, larger and more scattered in the tubes, smaller and more numerous on the pores, with rounded apex, hyaline, occasionally with long slender ampullaceous neck; *trama* of the hymenophore of the *Phylloporus*-type; *hyphae* without clamp-connections.

Chemical reactions: **KOH** on surface of pileus showing a nearly black ring around the stain. — **NH_3** and **NH_4OH** on surface of pileus, strongly and intensely greenish blue or blue, then fading to deep chocolate.

Habitat: On lawns near oaks (*Quercus virginiana* and *Q. laurifolia*) and shrubs in small groups, successively but not abundantly fruiting during the summer (from May to July and probably longer).

Distribution: Northern Florida.

Material studied: **Fla.** Alachua Co., Gainesville, May 1943, *R. Singer, F 2167* (**type,** FH); July 1943, *R. Singer, F 2530, F 2612, F 2620* (**cotypes,** FH).

This subspecies replaced the type form entirely in Gainesville while I was collecting there. However, Murrill has determined a more yellowish specimen with thicker stipe from Alachua County as *B. illudens* (FLAS), and it would not be surprising if this species were neither the type nor the ssp. *xanthomycelinus*. Murrill's *Ceriomyces alabamensis* belongs most probably to one of the subspecies of *X. illudens* but I was unable to find out to which. The spores are not as small as indicated by Murrill but rather 9.5–11.5 x 3.7–4.2 μ in the type specimens.

EXTRALIMITAL SPECIES

Xerocomus squarrosoides (Snell & Dick) Sing. comb. nov.

Boletinus squarrosoides Snell & Dick, Mycologia **28**:468. 1936.
Phylloporus squarrosoides Sing., Rev. de Mycol. **3**:170. 1938.

The excellent description of this species given by its author makes it possible to dispose of this species taxonomically without knowing the

ammonia reaction. There is abundant material at the Farlow Herbarium, authentic material as well as Farlow's material from Providence, R. I. (*Boletinus decipiens*) and Stow, Mass. (*Boletinus castanellus*), and D. H. Linder's collection (*B. subtomentosus*) from Canton, Mass., and besides a fine unpublished color plate (*Br. 312*). It usually has more boletinoid hymenophore than other species of this genus and its color is less yellow or less uniformly yellow than in the others except *X. Linderi*. The spores are melleous-brownish, smooth, asymmetric, ovoid with tapering apex or oblong-ellipsoid, without a distinct suprahilar depression, 9–12 x 4.5–6 μ, mostly about 9.8–10 x 4.8–5 μ; basidia 28–37 x (5.5)–7.7–9 μ, 4-spored; cystidia closely resembling the cystidia of *Phylloporus rhodoxanthus*, either hyaline or melleous, fusoid with mostly broadly rounded tip, more rarely ampullaceous or clavate, 40–73 x 7.5–12.2 μ; trama of the *Phylloporus*-type; hyphae without clamp connections. In 1938, the author placed this species in *Phylloporus*. In the present arrangement we take it with all other porous forms to *Xerocomus*.

Xerocomus Housei (Murr.) Sing. comb. nov.

Ceriomyces Housei Murr., N. Am. Fl. **9**:145. 1910.

The type (NY, NYS) has the spores still shorter than *X. squarrosoides*, ellipsoid-ovoid, smooth, melleous, 7.7–8.5 x 5 μ; basidia 28 x 9.7 μ, 4-spored; cystidia fusoid, narrowly clavate, or fusoid-ampullaceous, rather numerous 35–40 x (5)–9–9.5 μ; cuticle with an interrupted trichodermium-palisade, the terminal hyphae fusoid or subulate, or capitate, 17–42 x 7–22 μ; hyphae clamp-less. It seems that this North Carolina bolete, rarely collected and chemically not studied, belongs in section *Pseudophyllopori*.

Xerocomus Linderi Sing. spec. nov.

Pileo areolato, areolis fulvidis ("tawny 14"), subapplanato, 40 mm. lato, cuticula e trichodermio palisadiformi brevi-hyphoso nec non e catenulis suberectis sphaerocystarum consistente; tubulis carneo-cinnamomeis ("pinkish-cinnamon" R. in vivis), fractis caerulescentibus, amplissimis, angulatis; sporis subfusoideo-ellipsoideis, brunneolo-melleis, levibus, tenui-tunicatis, depressione supra-hilari praeditis, 11–12 x 4.7–5.2 μ; basidiis 30–38 x 9–11 μ, tetrasporis; cystidiis versiformibus, saepius clavatis; stipite argillaceo-cinnamomeo ("clay color") subtus, at ad apicem flocculis fuscidulis ("snuff brown") furfuraceis obsito, solido, aequali, 45 x 5 mm.; mycelio albo, ex hyphis 2.8–3.5 μ crassis cylindraceis consistente; carne sordide ochracea in siccis, tenuiore, odore saporeque haud notatis. Habitatio: Ad basin nidi termitum prope Banga, Liberia Africae, Octobri mense *D. H. Linder, 1211* (**type**, FH).

This is apparently a *Xerocomus* but the section is somewhat difficult to determine. It is in so many ways similar to *X. hemixanthus* and *X. squarrosoides* that we consider it as belonging in section *Pseudophyllopori*.

Xerocomus lanatus (Rostkov.) Sing. comb. nov.

Boletus lanatus Rostkov. in Sturm, Deutschl. Fl., Pilze **3**:77. 1844.
Boletus hieroglyphicus Rostkov. *l.c.* **3**:93. 1844.
Boletus Leguei Boud., Bull. Soc. Mycol. Fr. **10**:62. 1894.
Suillus lanatus Kuntze, Rev. Gen. Plant. 3^2:535. 1898.
Boletus subtomentosus var. *Leguei* Bat., Bolets, p. 19. 1908.

Xerocomus subtomentosus var. *Leguei* R. Maire, Publ. Inst. Botàn. Barcelona, **3**(4):43. 1935.

Boletus subtomentosus ssp. *spadiceus* var. *lanatus* Konr. & Maubl. Icon. Sel. Fung. **6**:463. 1938.

The author has seen material in Boudier's herbarium at Paris. According to Rostkovius it is found in beech woods, and according to Boudier, the spores are very broad, much broader than in *X. illudens*.

Xerocomus coniferarum Sing. nom. nov.

Boletus ferrugineus Bres., Iconogr. **19**, *pl. 915.* 1931, *non* Schaeff. *nec* Frost.

This is also the *B. spadiceus* "Fr." *sensu* Quél., Champ. Jura, p. 262. 1872, *X. spadiceus* (Fr. *sensu* Quél.) Quél., *B. subtomentosus* ssp. *spadiceus* (Fr. *sensu* Quél.) Konr. & Maubl. It occurs under fir in the Vosges Mts. in France, also in the Trentino, and the Caucasus.

Sect. **Subtomentosi** Fr., Epicrisis, p. 412. 1838 (sect. gen. *Boleti*).

Characters of the section: see key p. 287. Type species: *X. subtomentosus* (L. *ex* Fr.) Quél. Other species: *X. chrysenteron* (Bull. *ex* Fr.) Quél., *X. Zelleri* (Murr.) Snell *apud* Slipp & Snell. It is possible that some tropical species belong in this section. One of the species which the author tentatively places here, is:

Xerocomus Junghuhnii (Hoehn.) Sing. comb. nov.

Boletus Junghuhnii Hoehn., Sitz.-ber. k. Akad. Wiss. Wien, Math. Nat. Kl. **123** (I):87. 1914.

The type (FH) from Java which we have examined in order to be able to compare it with *X. brasiliensis*, shows very large pores in a very small carpophore. Hoehnel states that the pileus is dry. In one of the transparent bags containing type material, specimens of another species (a minute *Boletus*) are intermixed, but the descriptive notes seem to entirely correspond to the species which we take for the real *X. Junghuhnii*. Even there, we find the spores very variable in size but not so much in shape. They are pale melleous ("pale yellowish in masses" says Hoehnel but he had no good spore print) under the microscope, smooth, and varying between 9–10 x 3.8–4.2 μ in one mature specimen to (9.2)–10.2–13.3 x (3.8)–4.2–5.3 μ in another; basidia 23.8–25.3 x 6.8–8.8 μ; cystidia versiform, not always conspicuous, about 35–42 x 8.5–12.5 μ; hyphae of cuticle with yellow cell sap; clamps none; structure of the trama not with certainty decipherable.

Sect. **Parasitici** Sing., Ann. Mycol. **40**:43. 1942.

Characters of the section: see key, p. 287. The only species known is the circumpolar *X. parasiticus* (Bull. *ex* Fr.) Quél. Massachusetts material (*D. H. Linder & R. Singer*, Greenwood, Sept. 1943), and Paris material (R. Singer, Bois de Meudon, Aug. 1935) show the following chemical characters: **KOH** and $\mathbf{NH_3}$ on surface of pileus and on the yellow context

castaneous; **NH_4OH** on surface of pileus castaneous, eventually paler but with darker ring; **HNO_3** on surface of pileus castaneous, eventually with a bright orange ring; **$FeSO_4$** negative. The trama of alcohol-material from Middlesex Fells, Mass., shows an undifferentiated mediostratum, the outer larger part of the trama diverging but only slightly so, the non-diverging portion rather more hyaline than the diverging one, the latter of rather densely arranged hyphae without clamp connections; both strata continuing around the bottom of the tube. The inverse coloration of the tramal strata as compared with the *Boletus*-type may be due to the preserving medium. In the same material some 1.5 mm. broad and 4.5 mm. high primordia have been sectioned by the author since they represented the youngest stage in which the beginning hymenophore could still be demonstrated. These primordia showed the presence of a distinct ring-hole which is in apparent contradiction to previous statements in the literature. I am at a loss to explain these facts unless the ring-hole in our preparations is also due to an alternating influence on the tissue caused by the preserving fluid. *X. parasiticus* has not yet been found in Florida, notwithstanding the abundance of its hosts, *Scleroderma* spp., in the state.

Sect. **Brasilienses** Sing. sect. nov.

Pileo tomentoso et viscido; poris initio parvulis, deinde amplis vel pro ratione amplissimis; sporis exiguis (6–9.3 x 2.8–4.2 μ); trama typi *Phyllopororum*; in tropicis et subtropicis.

Characters of the section: see key, p. 287 and the above Latin diagnosis.

16. **Xerocomus brasiliensis** (Rick) Sing. comb. nov.

Boletus brasiliensis Rick, Ann. Mycol. **3**:235. 1905.

Pileus pale or light yellow, felty tomentose and at the same time viscid, sometimes with narrow sterile margin, hemispheric to convex, 10–20 mm. broad, rarely broader. — *Hymenophore* greenish yellow, slightly depressed around the stipe, tubes of medium length, pores concolorous, wide when mature, inequal, irregular; spore print not obtained but judging from small deposits on the carpophore itself, probably olive brown. — *Stipe* pale melleous to yellow, smooth or almost so, sometimes mealy on top, solid, cylindric, about 21 x 3–5 mm., rarely larger. — *Context* subconcolorous with the surface, unchanging, odor none.

Spores 6–9.3–(10) x 2.8–4.2 μ, mostly around 8.5 x 3.5 μ with 0.4 μ thick wall, smooth, melleous, subellipsoid-cylindric or somewhat variable in shape; *basidia* (13)–19–28 x (4)–6.5–8.8 μ, 4-spored with 4.5 μ long sterigmata; *cystidia* inconspicuous and infrequent, hyaline, not or very little incrusted, fusoid-ampullaceous, *e.g.* 17.5 x 5.5 μ; *trama* very homogeneous, rather hyaline, of almost equal density and without an appreciably darker colored zone in the middle, of the *Phylloporus*-type; *cuticle* of the dried material available not showing any particular structure; *laticiferous vessels* present, melleous, all *hyphae* without clamp connections.

Chemical reactions: **KOH, NH_4OH, NH_3** everywhere brown.

Habitat: On the ground in open places and in dense subtropical woods (low hammock type) on humus and débris, even up to two feet on the living trunks of trees, never near conifers, solitary or in small groups, in Florida fruiting in August.

Distribution: Florida (rare), Brazil (frequent). Exact limits unknown.

Material studied: **Fla.** Highlands Co., Highlands Hammock State Park, *R. Singer, F 641* (FH); **Brazil:** Near São Leopoldo, numerous specimens including parts of the **type** and **authentic** material in Rick: *Fungi Austroamericani, 1909* (FH).

The above description proves that this is a *Xerocomus*, and not related to *Boletus fulvidus* (*i.e. Gyroporus castaneus*) as suspected by Rick. This small and inconspicuous bolete has not been found, and, for that matter, not been looked for in the West Indies and northern South America.

Sect. **Pseudoboleti** Sing. sect. nov.

Pileo viscidulo at subtomentoso; tramate structura intermedia inter typum *Phylloporum* et typum *Boleti* gaudente; vaporum ammoniacalium ope brevissime caerulescente-nigrescit; in silvis coniferis borealibus.

This is the section for the species with intermediate tramal structure that cannot easily be linked with any group within the genus *Boletus, sensu str.* In the type and only species, *X. badius* (Fr.) Kühn. *ex* Gilbert (*Boletus badius* Fr.) the subhyaline lateral stratum is slightly looser than the mediostratum and its hyphae moderately but distinctly divergent, touching each other and somewhat broader than in the mediostratum where the hyphae are regular-subinterwoven and somewhat (very pale) colored. The spores are in some specimens within the usual limits in *Xerocomus*, in others larger. Coker and Beers suggest that the American *X. badius* has the spores smaller than the European type. However, material collected by me near Lynnfield, Mass. (FH) has the spores 11.5–18.5–(24) x 4–5 μ, and material from Austria (FH) has them 12.5–16.5 x 5–5.7 μ. Some authors consider *X. badius* as a *Suillus* but aside from the habitat, and the subviscid pileus there are no other characters to support this view. The blackish-blue flush with ammonia on the surface of the pileus would rather support Gilbert's proposal to consider it as a *Xerocomus*. It has not been observed in Florida.

SPECIES INCOMPLETELY KNOWN

Xerocomus Boudieri Sing., Ann. Mycol. **40**:43. 1942.

This species has not been studied thoroughly enough to decide whether it belongs in *Xerocomus* as redefined in this paper. The same is true for *Boletus Roxanae* and *B. innixus* Frost (at least authentic material at FH) which evidently are very close to *X. Boudieri* if not identical. Neither of these three species has been observed in Florida.

Xerocomus lignicola (Kallenbach) Sing., Ann. Mycol. **40**:43. 1942.

Boletus lignicola Kallenbach, Pilze Mitteleur. **1**:57. 1929.

With the data at hand, I am unable to decide whether this is a *Xerocomus* spec. or a form of *Phlebopus sulphureus* (Fr.) Sing. (*Boletus sulphureus* Fr.).

Xerocomus tumidus (Fr.) Gilbert, Bolets, p. 145. 1931.
Boletus tumidus Fr., Hym. Eur., p. 501. 1874.

Fries' species is dubious as its author states himself. Gilbert bases his treatment on Peltereau's emendation but this also is insufficient for generic determination.

SPECIES EXCLUDENDAE

Xerocomus amarellus Quél. is *Suillus piperatus* var. *amarellus* (Quél.) Sing.
Xerocomus gentilis (Quél.) Sing.

This is treated as *Pulveroboletus gentilis*. The same disposal is made of *Xerocomus auriporus* (Peck) Sing. and *X. flaviporus* (Earle) Sing. In fact, the entire section *Auripori* has been transferred to *Pulveroboletus*.

Xerocomus griseus (Frost) Sing.=*Boletus griseus* Frost.

The section *Grisei* has been reunited with *Boletus*.

Xerocomus impolitus (Fr.) Quél. is *Boletus impolitus* Fr.
Xerocomus mirabilis (Murr.) Sing. is *Boletellus mirabilis* (Murr.) Sing.

The section *Mirabiles* has been transferred to *Boletellus*.

Xerocomus pulverulentus (Opat.) Gilbert.

This species is here retransferred to *Boletus*. *Xerocomus radicans* (Pers. *ex* Fr.) *sensu* Quél. (*non* Kallenbach) is the same.

Xerocomus rubellus (Krombh.) Quél. is here treated as *Boletus*.

Xerocomus chrysenteron var. *versicolor* Quél., *X. armeniacus* Quél., *X. pruinatus* (Fr.) Quél., and *X. versicolor* (Rostkov. *non* S. F. Gray) Gilbert are forms of the same species. In this country, *Boletus bicolor* Peck and *B. fraternus* Peck belong in the same complex, but they have never been considered as *Xerocomi*.

Xerocomus sulfureus (Fr.) Quél. is *Phlebopus sulphureus* (Fr.) Sing.
Xerocomus spec. Heim, Bol. Soc. Broter. **13**(2):53. 1938 is *Boletochaete* spec.
Xerocomus spec. Snell *apud* Slipp & Snell, Lloydia **7**:50. 1944 is *Boletus* spec.

EXPLANATION OF PLATE I

All drawings of spores are at a magnification of × 2000; all other drawings of microscopic structures at × 1000; figs. 5–7 shown at natural size.

Fig. 1–4. *Gyroporus purpurinus* (Snell) Singer
1. Structure of the cuticle of the pileus.
2. Cheilocystidia of the hymenophore.
3. Basidium.
4. Spore.

Fig. 5–7. *Boletinus decipiens* (B. & C.) Peck
5. Gasteromycetous conditions of the carpophore sketched at natural size.
6. Longitudinal section of an immature carpophore (natural size). The veil closely applied to the surface of the hymenophore.
7. Longitudinal section of a mature carpophore (natural size), the remnant of the veil remaining as a relatively closely attached annulus.

Fig. 8–10. *Suillus cothurnatus* ssp. *thermophilus* Singer
8. Part of the hymeniform fragments on the surface of the stipe that are found in and around the glandular dots.
9. Large dermatocystidia, another element of the glandular dots of the stipe.
10. Spore.

Fig. 11–12. *Phylloporus rhodoxanthus* ssp. *foliiporus* (Murr.) Singer
11. Spores.
12. Cystidia of the hymenophore.

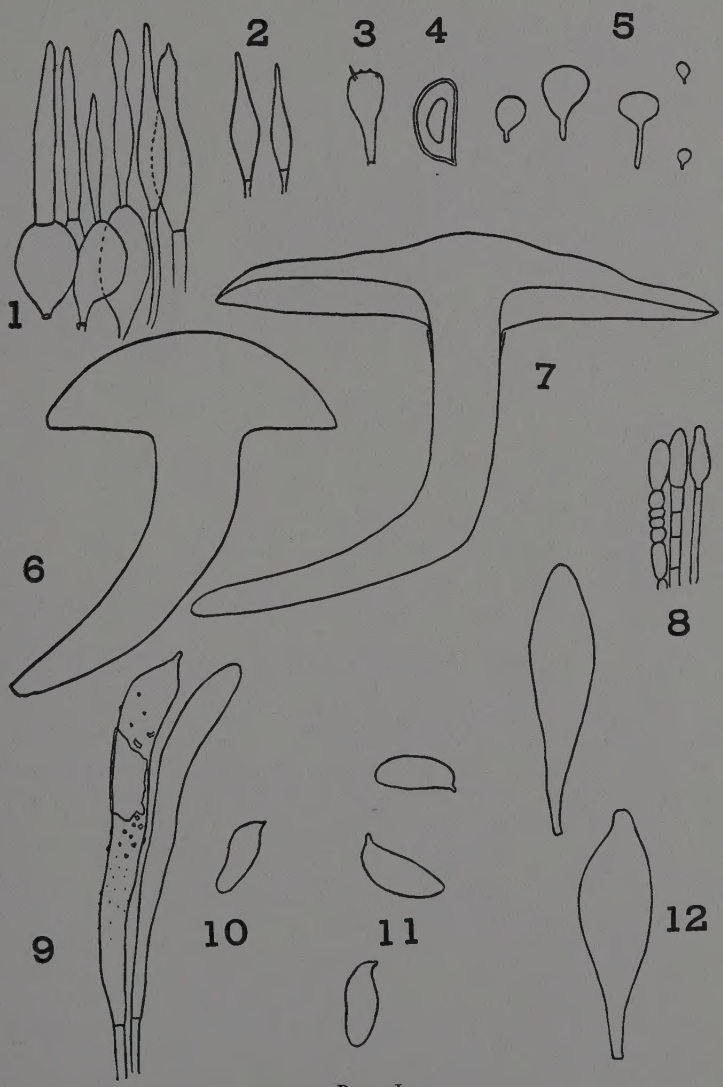

PLATE I